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No. 3 Vol. 3

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BY

JOHN M. CLARKE M.A. Ph.D.

State paleontologist

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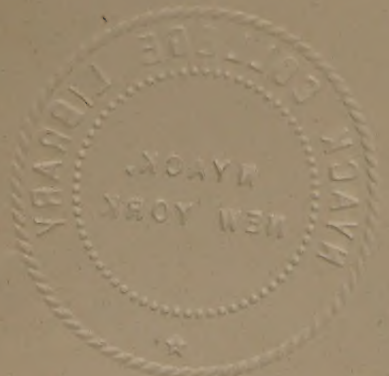
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PREFATORY NOTE

The original purpose of this work was solely to depict the character and composition of the Oriskany fauna of Becraft mountain, which of itself displays many features of interest. In its progress, however, various questions have arisen which concern the intrinsic value of the fauna and its importance in correlation. Yet without an understanding of the fauna itself it would be impracticable to discuss the latter problems, and for this reason the title of the paper is restricted to the principal argument of the work, to which the discussions of somewhat broader scope are corollaries.

THE ORISKANY FAUNA OF BECRAFT MOUNTAIN, COLUMBIA COUNTY, NEW YORK

INTRODUCTION

The existence of a fauna in the New York series linking together in the character of its species that of the calcareous shales and limestones of the Lower Helderberg and that which has been regarded as pertaining to the normal Oriskany sandstone of Oneida county and westward sections, was first brought to public notice in 1892, in a paper published by Prof. Charles E. Beecher and accompanied by a list of the species prepared by the writer.[1]

The interesting bearings of this assemblage of species, its new forms and new associations and its real importance in the correlation of the lower Devonian are sufficient reason for presenting its characteristics in detail.

The fauna in its highest development is found at Becraft mountain, about 2 miles east of the Hudson river, near the city of Hudson in Columbia county. Strata of the same horizon occur at other localities in the state and carry some of the characteristic species which appear in profusion on Becraft mountain. Such outcrops are found in Ulster and Orange counties on the west side of the Hudson, but they quickly disappear in the westward extension of the Oriskany formation.

Chapter 1

STRATIGRAPHIC STRUCTURE OF BECRAFT MOUNTAIN

Becraft mountain has been the subject of geologic observation since the early report of W. W. Mather on the geology of the first district of New York (1842). A brief account of the succession and structure of the rock beds will be found on page 351 of that work, and a very

[1] Notice of a new Lower Oriskany fauna in Columbia county, N. Y. by C. E. Beecher, with an Annotated list of fossils, by J. M. Clarke. Amer. jour. sci. 1892. 44: 410–14.

generalized section across the mountain from east to west is given on plate 24, figure 6. The mountain is an outlier of principally early Devonic strata about 2 miles in north and south extent, and these rest unconformably, as shown by Mather, J. D. Dana and W. M. Davis, on the upturned slates of the Hudson river formation. The most complete and interesting portrayal of the structure of this area is that given by Davis.[1]

Accompanying that paper is a sketch map of the mountain giving the stratigraphic succession both in plane and in section. It is not my purpose to enter into great detail with reference to the structure of this area, but, to point certain of my observations, I have taken the liberty to represent on a somewhat different scale, the map given by Prof. Davis, with some emendations of the contacts of the various formations and the addition of two important divisions not noted by him.

Over the northern portion the mountain is a simple, low syncline; and toward the central part it shows a double syncline separated by a very short fold, at which the layers of the Becraft limestone come to the surface. Again, farther south the duplicate form of this syncline is in a measure lost and the structure gradually becomes more complicated, particularly at the southeast edge of the area. This was indicated by Mather, who in one of his sections suggested that the rocks at this point were overturned. Davis likewise left the structure here in some doubt. The first strata resting on the upturned Hudson river slates,[2] are those of the Tentaculite (Manlius[3]) limestone, which nearly inclose the entire area and on the northeast and southwest boun-

[1] Amer. jour. sci. 1883. 3d ser. 26: 381–89.

[2] At Mount Moreno, just south of the city of Hudson, these slates carry a fauna with Coenograptus gracilis, Didymograptus sagittarius, D. tenuis Hall and other graptolites identical with those of the Normanskill shales at Kenwood and Glenmont, Albany county. The taxonomy of the great mass of so-called Hudson river slates in the Albany region which has recently been studied by Ruedemann points to the early Trenton age of the Normanskill shales and inferentially of these slates lying beneath the Manlius limestone of Becraft mountain.

[3] *See* footnote, p. 8

daries are rendered very conspicuous by their strong escarpment. Over this lies the Pentamerus (Coeymans[1]) limestone, characteristically developed, and thereon a well defined mass of Catskill shaly (New Scotland[1]) limestone. The latter is overlaid by the Becraft[1] limestone. To these four formations Davis assigned the following thicknesses:

Manlius limestone	20–30 feet
Coeymans limestone	40–50 feet
New Scotland beds	50–60 feet
Becraft limestone	40–50 feet

[1]The requirements of uniformity in stratigraphic nomenclature are compelling the relinquishment of such of the early division names in the New York series as do not indicate localities of exposure. In order to save to the state of New York its preeminent title to the names of these divisions and in the farther hope of perpetuating an equable grouping of the stratigraphic units of the New York series, the writer, in conjunction with Charles Schuchert, has recently (*Science.* Dec. 8, 1899, *American geologist.* Feb. 1900) proposed the arrangement of the formations given in the following table. This proposition has been carefully considered and is the result of mature deliberation.

NEW YORK SERIES

ERA OR SYSTEM	PERIOD OR GROUP	AGE OR STAGE
Cambric or Taconic	Georgian	Georgia slates
	Acadian	
	Potsdamian	Potsdam sandstone and limestone
Champlainic[1] (Lower Silurian and Ordovician)	Canadian[3] (Paleochamplainic)	Beekmantown limestone[15] Chazy limestone
	Mohawkian[4] (Mesochamplainic)	Lowville limestone[16] Black river limestone Trenton limestone
	Cincinnatian[5] (Neochamplainic)	Utica shale Lorraine beds[17] Richmond beds (Ohio and Indiana)

NEW YORK SERIES *continued*

ERA OR SYSTEM		PERIOD OR GROUP	AGE OR STAGE
Ontaric[2] or Siluric		Oswegan[6] (Paleontaric)	Oneida conglomerate Shawangunk grit Medina sandstone
		Niagaran[7] (Mesontaric)	Clinton beds Rochester shale Lockport limestone Guelph dolomite
		Cayugan[8] (Neontaric)	Salina beds Rondout waterlime[18] Manlius limestone[19]
Devonic	Paleodevonic	Helderbergian[9]	Coeymans limestone[20] New Scotland beds[21] Becraft limestone[22] Kingston beds[23]
		Oriskanian[10]	Oriskany beds
	Mesodevonic	Ulsterian[11]	Esopus grit[24] Schoharie grit Onondaga limestone
		Erian[12]	Marcellus shale Hamilton beds
	Neodevonic	Senecan[13]	Tully limestone Genesee shale Portage beds (Naples beds, Ithaca beds, Oneonta beds, local facies)
		Chautauquan[14]	Chemung beds (Catskill sandstone[25] local facies)

1 Champlainic. This most appropriate designation was introduced by the concurrence of the four geologists for the formations here assigned to it (exclusive of the Potsdam sandstone), and it has clear right of way over the later application of the name to the period of postglacial alluvium. That the later term has become ingrained in

literature renders it all the more conspicuous as an infraction of the law and of the rights of the men who first proposed it. In the face of Champlain, 1842, the term Ordovician has no standing.

2 Ontaric. Vanuxem placed the base of the Ontario division at the "gray sandstone," Hall and Emmons at the Medina, Mather at the Shawangunk grit. Vanuxem and Hall terminated the above division with the Niagara, Emmons included the Salina and waterlime. Growing evidence fully indorses Emmons's view as to the termination of the group and period with the clearing of the Salina sea.

3 Canadian. This term has the prestige of time and priority.

4 Mohawkian (new). Conrad and Vanuxem made use of the term, Mohawk limestone, for certain of the calcareous layers beneath the Trenton, but they differed so widely in their application of the term that in the summation of their results, the geologists decided to abandon it. The name is here revived with a broader meaning. The valley and watersheds of the Mohawk river afford typical exposures of all members of the group.

5 Cincinnatian. The formations of the Neochamplainic are not as completely developed in the state of New York as in Ohio and Indiana. In the latter sections the Lorraine fauna is represented, but is followed above by the well defined fauna of the Richmond beds. Probably in no other region is the succession of these faunas so complete as about Cincinnati, and this fact justifies the recognition of the term Cincinnatian, which already has historic value. For a full description of the series by Winchell and Ulrich, see *Geol. and nat. hist. sur. of Minn.* 1897. v. 3, pt 2, p. 101–5.

6 Oswegan. This name is appropriate on account of the widespread occurrence of the Oneida and Medina formations in Oswego county, N. Y. Vanuxem employed the term, Oswego sandstone, for the formation subsequently and by common consent called Medina sandstone. In reviving the name, though with a broader meaning than in its original use, it derives its title from its early date.

7 Niagaran. In the sense suggested by Prof. Dana.

8 Cayugan (new). The divisions of this group are knit together by lithologic and faunal characters and are distinctly Ontaric. The outcrops are typically exposed about the north end of Cayuga lake, N. Y.

9 Helderbergian. The present state of our knowledge does not permit the use of the term, Helderberg, in its original scope. The Helderberg division was made to embrace formations now regarded as constituting the lower and part of the middle Devonic. We propose to restrict the term Helderbergian to the formations currently known as Lower Helderberg, excluding the Tentaculite limestone.

10 Oriskanian. The Oriskany formation varies considerably in the character of its sediment. Its calcareous facies is highly developed in eastern New York, while the more silicious sediment excludes all others in the central part of the state. The fauna of the Oriskany from its lowest beds, as at Camden Tenn., to its highest beds, as in the province of Ontario, shows progress in differentiation, but it is not yet practicable to subdivide the New York development of the fauna.

11 Ulsterian (new). From the outcrops of all the members in Ulster county, N. Y.

12 Erian. The Erie division comprised the formations from the top of the Onondaga limestone to the top of the Chemung. We propose to save the term to the New York nomenclature by reviving it with a restricted meaning.

13 Senecan (new). In Seneca county and along the shores of Seneca lake are excellent exposures of these beds.

14 Chautauquan (new). From exposures in Chautauqua county, N. Y.

15 Beekmantown limestone (new). The Calciferous sandrock of Eaton and authors generally. This formation took its original name from sections in the Mohawk valley, where the rocks are without fossils. At Beekmantown N. Y., the normal fauna is finely developed and the rock section essentially complete.

16 Lowville limestone (new); instead of Birdseye limestone of common use. Lowville is a town in Lewis county, N. Y., where these beds are well exposed.

17 Hudson river beds. It is becoming increasingly evident that the great mass of shale in the Mohawk and Hudson river valleys which was designated at an early date by this term is resolvable into horizons extending from the middle Trenton to and including the Lorraine beds. At present it seems unlikely that, when this determination of horizons has been carried through the series, any part will remain to which the original term can be applied by virtue of its distinctive fauna, though it may still serve to designate a facies of the formations mentioned.

18 Rondout waterlime (new). From the fine development of these beds in the extensive cement quarries at and near Rondout N. Y.

19 Manlius limestone. Tentaculite limestone of Gebhard, Mather and later writers. The name here used was introduced by Vanuxem and is entitled to first consideration. Manlius is the place of typical exposure in Onondaga county, N. Y.

20 Coeymans limestone (new); and

21 New Scotland beds (new). These terms designate respectively the Lower Pentamerus (Helderberg and Pentamerus limestones of the New York geologists) and the Catskill or Delthyris shaly limestones. Coeymans and New Scotland are adjacent towns in Albany county, N. Y., through which runs the Helderberg escarpment, affording the finest exposures of these formations.

The Becraft limestone, a heavy bedded rock, hard, gray and subcrystalline, occupies the position of the Scutella limestone as developed in the Helderberg and Schoharie sections and probably represents both the Scutella and Upper Pentamerus limestones of those sections. Over the summit of the Becraft limestone on the eastern ridge of the moun tain the surface slopes gradually downward to the west and follows the dip of the strata.

At the base of this slope is a marshy area draining toward the south, and in the vicinity of this low region and above it for about one third the width of the slope is the outcrop of the Oriskany which was not recognized by Prof. Davis. This is largely concealed under the soil, and there are no very clearly defined exposures of it except where the soil has been removed from small areas, in which case the surfaces rather than the edges of the strata are seen; but a considerable quantity of the rock that has become loose has worked up through the soil, and is not only found near its proper site but is scattered abundantly through the stone walls in the immediate vicinity of the strata themselves, so that the material is to be looked for and found most abundantly on the westward slope of this syncline and in the vicinity of the little stream throughout its extent. These strata, highly silicious, hard, dark limestones, have been most favorably exposed to decomposition, and in consequence the calcareous matter has

---

22 Becraft limestone. This name was introduced by N. H. Darton with the sanction of Prof. James Hall, for the beds previously known as the Upper Pentamerus and Scutella limestones of the Helderberg sections. The present name is derived from Becraft mountain, Columbia county, N. Y.

23 Kingston beds (new). The "upper shaly beds" of W. M. Davis, which are typically exposed and attain a thickness of 250 feet in the vicinity of Kingston N. Y.

24 Esopus grit. Proposed by Darton with the approval of Prof. Hall, for the old term Cauda-galli grit. It has been suggested by Frech that the Esopus grit should be regarded as a part of the arenaceous sediments of the Oriskany. The very few fossils which it contains, however, do not as yet fully indorse this suggestion.

25 Catskill sandstone. This is an approximate expression of the value of this formation. Catskill sedimentation doubtless began as early as Portage time, its representation during which is expressed in the term, Oneonta beds.

Geological Map
of the
Becraft Mountain Synclinal

Manlius (Tentaculite) | Coeymans (Pentamerus) | New Scotland (Shaly) | Becraft | Kingston (Upper Shaly) | Oriskany

Esopus | Schoharie | Onondaga

The Hudson River Slates on the Outskirts of this Area are not Represented

SCALE
1 inch = 40 Rods

been largely leached out for a considerable depth on all exposed surfaces, only a porous residuum remaining. This light, rusty and firm rotten stone retains the external and internal casts of the fossil remains with which it is filled, in exquisite detail and forms excellent material for study. Only by hastening nature's process with acid can the fossils be made out from the black and cherty or unchanged calcareous cores of this rock.

It is not easy to estimate the actual thickness of these strata at this place, as it would appear that they have been partly eroded, but there is no evidence above them of the black chert beds which terminate the Oriskany deposits in the Ulster, Albany and Schoharie county sections, nor of the characteristic white quartz sandstone of the central sections. These beds rest on an argillaceous limestone, which seems to be present in only slight force and is almost wholly if not quite concealed; the "upper shaly" or Kingston limestone, blocks of which are frequently found in close association with the Oriskany and so closely resemble the latter that considerable care and experience are requisite to avoid confounding the two. The author has therefore taken utmost care in making up the list of species of the Oriskany to eliminate all this "upper shaly" material from consideration. This is readily done after experience in recognizing the lithologic differences, aided by the fact that the Kingston limestone contains but very slight intermixture of Oriskany species. The Helderbergian species here registered, therefore, occur in Oriskany limestone and in immediate association with Oriskany fossils.

From the axis of the syncline, specially along the north and south road crossing the mountain, is a ridge of gray, sandy grit with slaty cleavage so strongly developed that the original bedding is entirely lost. This rock covers a large area from the center of the region and constitutes the high ridges which cap both of the synclinals. Prof. Davis regarded all of this rock, which in places rises in very sharp escarpments, particularly on the east of the southern part of the road mentioned, as the Cauda-galli grit (Esopus slate). I have found however in various places, specially near the junction of the middle road with a crossroad from the west starting in at the glue factory, that this rock contains

fossils wedged in between the cleavage planes and lying with their surfaces parallel to the true bedding. These are exceedingly difficult to extract, but among them it has been possible to identify Dalmanites anchiops; Phacops, a fragment of a head without spine on the genal angle, (cf. P. bombifrons); Coelospira (cf. camilla); Chonetes, large (cf. arcuata). These fossils are sufficient to show the presence here of the Schoharie grit. They have not been found throughout the entire thickness of this formation, and are under all circumstances very rare, but, while we may safely ascribe a portion of the formation to the Esopus slate, it is necessary to regard at least that portion represented as such on the accompanying map as belonging to the Schoharie grit. It is observable that, where these rocks contain fossils, some calcareous matter is present.

The existence of the Corniferous limestone, the highest and latest of all the formations, was also determined by Prof. Davis; and to this he ascribed a thickness of 10 to 15 feet, but he speaks of having found no fossils in it and is somewhat uncertain as to the correctness of his reference to the limestone of this formation. This rock is a chert-bearing, light colored, almost white limestone, the chert lying in layers and the entire thickness of the mass being from 15 to 20 feet. In stratification it is essentially horizontal, or with a very slight dip east. There can be no question that it is the Onondaga limestone. The layers are sparsely fossiliferous, showing traces of rugose corals, particularly Zaphrentis and well defined examples of the brachiopod Spirifer raricosta. Directly beneath the outcrop of these beds are seen beds without flint which are calcareous and shaly or shaly with calcareous lenses, the limestone itself being blue and the shale weathering brown or rusty gray. These beds show conclusive evidence of false bedding, as a vertical slaty cleavage is highly developed, and in this respect they resemble those seen near the roads below, which we have already referred to the Schoharie grit. They thus appear to lie at a high angle beneath the chert-bearing beds, but are unquestionably conformable to them, as is shown by the nearly horizontal position of the fossils they contain. Nevertheless, these fossils, which are so wedged into the rock that it is difficult to release them, are variously distorted by pressure and only very compact bodies like solid corals have escaped such distortion. The following species have been determined from these layers.

Odontocephalus selenurus; Spirifer varicosus; Atrypa reticularis, large and rotund; Leptaena rhomboidalis; Strep. torhynchus pandora; Chonophyllum; Zaphrentis; Favosites, branching; Stromatopora or Fistulipora, incrusting. With the evidence before us then, we have no hesitation in concluding that the succession of the upper Helderberg beds from the top of the Oriskany sandstone upward is fairly complete, representing the Esopus slate, the Schoharie grit, the non-chert-bearing Onondaga limestone and characteristic "Corniferous" limestone.

Chapter 2

DESCRIPTION OF THE FAUNA

TRILOBITES

Dalmanites (Synphoria) stemmatus sp. nov.

Plate 1, fig. 6–16; plate 2, fig. 1, 2

1892. *Dalmanites, sp. nov. A*, Clarke, op. cit. p. 412

Species attaining considerable size. Cephalon convex, abruptly sloping to the genal margins. Genal extremities somewhat produced but relatively short and terminating in broad, obtuse angles. Dorsal furrow deep except at the junction of the glabellar lobes with the palpebral lobe, where it becomes shallow and very much elevated. Frontal lobe of glabella large, rounded in front, slightly elongated at the axial extremity but not projecting beyond the frontal border or facial suture. First lateral furrows long, deep and oblique, extending nearly three fourths the diameter of the lobe. Glabellar surface behind the frontal lobe slightly if at all depressed medially. Second and third lobes wholly confluent at their extremities, often but a remnant of the second lateral furrows remaining. Together these coalesced lobes have a subtriangular or subclavate outline and are convex and elevated at their distal extremities, rising above the full hight of the glabella and almost to the hight of the palpebral lobe. The third lobes are small and narrow,

making an annular segment, varying but little in width; their extremities are almost concealed beneath the projecting lobes in front. Occipital furrow deep; occipital segment long and very much arched; no central spine or tubercle. Cheeks with steep lateral slopes; somewhat concave within the thickened margin. Furrows beneath the eyes deep, narrow, with elevated margin having a vertical, outward slope. Occipital furrow widening from the dorsal furrows outward and coming to a rather abrupt termination without meeting the submarginal depression of the cheek or extending on the genal expansion. Eyes large, elevated, the palpebrum higher than the palpebral lobe.

The thickened border bears a row of crenulations or crescentic ornamental processes, which are the most extended at the anterior extremity; here also the anterior three of these processes are somewhat coalesced. From this extremity may be counted, on both sides of the terminal process, from 12 to 15 similar processes, becoming uniformly smaller toward the genal extremities and finally disappearing altogether at or near the lateral termination of the facial suture. In small specimens the number of these processes may be considerably less.

The surface of the cephalon is ornamented, on the frontal lobe of the glabella, with coarse pustules of varying size; this lobe also bears the elongate median scar which occurs in many species of the genus. The coalesced second and third lobes are also pustulose but less strongly. The cheeks directly beneath the eyes bear traces of low ramifying grooves similar to those found in Dal. pleuroptyx of the Helderbergian fauna and Dal. anchiops of the Schoharie grit.

Thorax not observed.

Pygidium very broadly triangular, the length and width being as 2 to 3. The margin curves slightly outward on each side and terminates behind in a broad, rounded extremity which is slightly elongated but is not produced into a spine. The axis bears 10 or 11 annulations, and the pleurae 9 or 10. The ribs are undivided by a median groove and are without coarse tubercles.

Observations. This interesting species shows its immediate affinities in many of its structural features. The peculiar ornamentation of the

frontal margin of the cephalon is possessed in less degree and different quality by several antecedent species. Thus as far back as the Dal. vigilans Hall, and Dal. verrucosus Hall of the later Niagara (Waldron) fauna there is a pronounced development of a short and simple spatulate process at the anterior extremity. In the Dal. pleuroptyx Conrad, of the Helderbergian, this process becomes broadened and divided, the divisions taking on the character of those in Dal. stemmatus, though being less numerous and of less extent along the border. In Dal. anchiops Green, of the Schoharie grit, a similar character is manifested,[1] extending for a short distance on either side of the extremity. Dalmanites (Odontocephalus) selenurus Eaton, of the Onondaga limestone, has the frontal margin developed by perforation into incisor-like processes, which again extend but a short distance from the extremity, while in Dal (Corycephalus) regalis Hall, of the Schoharie grit, the processes are blunt, distant and extend to the ends of the cheek spines. In the limestone beds at Port Jervis, the "trilobite beds" of Barrett, are the species Dal. dentatus Barrett and Dal. dolphi Clarke, the former with a row of pointed triangular processes extending nearly to the extremities of the cheek spines, the latter with a stronger compound anterior process and two or three sharp lateral processes on each side. Thus the marginal ornamentation of the head is seen to be subject to much variation, and from the simple anterior extension of the frontal border manifested in some of the late Siluric species, through the Dal. pleuroptyx of the early Devonic into Dal. stemmatus of the Oriskany, there has been a simple intensification and extension of the type of crenulate ornament. Here, however, the line ends, to be replaced and followed by the various phases above mentioned.

As to the employment of the term Synphoria, which is used in the title of this species, a few remarks may be made. To some of the ornamental expressions of Dalmanites referred to, generic or subgeneric terms have been applied, e. g., Odontocephalus for Dal. selenurus, Corycephalus for Dal. regalis, etc. It

[1] *See* Paleontology of New York. v. 7, pl. 10, fig. 11.

seems of very doubtful propriety to attempt to carry out such distinctions in this genus, and it is proper to make this remark here lest the outstanding ornamental variations not yet included under such subdivisions offer a temptation for the erection of parallel divisions. A much more fundamental character is found to exist in many of these Devonic Dalmanites, viz, the coalescence of adjacent members of the first and second pair of glabellar lobes. This is a difference of real significance in the anatomy of the animal, and it distinguishes a considerable number of forms from the normal Dalmanites in which the division of the lobes named is complete.

In the species of the early Siluric such coalescence is obscurely manifested, as in Dal. (Pterygometopus) eboraceus Clarke and Dal. (Ptery.) intermedius Walcott, but here in association with other characters which have been found a basis for a subgeneric distinction. The upper Siluric was a period of full, typical development of Dalmanites, and we observe that the Helderbergian species of the genus maintain their typical character in this respect. Dalmanites stemmatus is the earliest Devonic form in which coalesence is pronounced. Then follow Dal. anchiops Green and var. sobrinus H. and C., Dal. regalis Hall, of the Schoharie grit, Dal. selenurus Eaton, Dal. macrops Hall, Dal. diurus Green, Dal. calypso Hall and Dal. myrmecophorus Green of the Onondaga limestone. Within this group of species we find much diversity of marginal cephalic ornament: in Dal. macrops, Dal. calypso and Dal. diurus the frontal border is undivided; in Dal. anchiops it is moderately crenulated; in Dal. selenurus it is divided into incisor-like processes (Odontocephalus); in Dal. regalis the processes are different and extend over the entire margin (Corycephalus); in Dal. myrmecophorus the cephalic margin is not known, but the pygidial margin is highly modified (Coronura).

Turning to the Devonic species of this genus which possess the typical separation of the first and second lobes, we may enumerate Dal. pleuroptyx Conrad, Dal. dentatus Barrett, Dal. dolphi Clarke, of the Helderbergian, Dal. boothi and var. calliteles Green, of the Hamilton shales; the first three bearing

cephalic ornament and the others with none, but possessing highly characteristic pygidia (Gryphaeus). It seems therefore very probable that the term Synphoria, introduced by the writer some years ago, in its application to the former group of species having coalescent glabellar lobes, may prove of subgeneric significance in distinguishing such forms from the typical Dalmanites.

Dalmanites (Synphoria) stemmatus, var. convergens var. nov.

Plate 2, fig. 3-5

1892. *Dalmanites sp. nov. A.* var. Clarke, op. cit. p. 412

Not infrequent in this fauna are small pygidia of Dalmanites having the same degree of annulation as Dal. stemmatus but with a more slender and tapering outline. At the posterior extremity, also, there is a short but acute termination. A few cranidia of corresponding size show a slight crenulation of the anterior margin.

Dalmanites phacoptyx Hall and Clarke

Plate 2, fig. 10

1888. *Dalmanites phacoptyx* Hall and Clarke, *Paleontology of New York.* 7: 31, pl. 9a, fig. 23–27

This species was founded on some large but incomplete pygidia from the Upper Helderberg (Ulsterian) at North Cayuga, Ontario, which are characterized by their narrow, divided pleural ribs, long, cylindric tail spine and irregularly tubercled surface, some of the tubercles being large and having the form of spinules. These spinules occur without arrangement on the pleural ribs and on some of the segments of the axis. Lesser tubercles are scattered over the surface and are crowded on the sides of the axis.

A few specimens representing this species have been found in the Oriskany.

Dalmanites bisignatus sp. nov.

Plate 2, fig. 6-8

1892. *Dalmanites sp. nov. B*, Clarke, op. cit. p. 412

Cephalon and thorax not known.

Pygidium elongate triangular, sloping to a sharp angle which may be extended into a short, flat spine. Axis quite slender and with

slightly incurving dorsal furrows. Segments transverse and narrow, 12 to 14 in number on internal casts, bearing a double median row of strong and sharp tubercles with fine and faint pustules at the side. Pleurae with 12 ribs which are separated by broad, flat grooves; these ribs are narrow, flattened above and divided by a fine median, linear sulcus. Very small tubercles are scattered irregularly over the ribs.

These are pygidia quite closely similar to that of Dal. dentatus Barrett, of the Port Jervis limestone and the Dal. pleuroptyx Conrad, of the Helderbergian. The differences are these: in Dal. dentatus the ribs of the pleurae are fewer in number, more deeply divided by the sulci and more strongly pustulose; on the axis the median row of tubercles consists of two, three or four with lesser ones at the sides. In Dal. pleuroptyx the number of axial and pleural segments is generally more than here, the outline of the shield is less sharply triangular and, while the pleural ribs are of much the same character, the ornamentation of the surface is different, consisting of a fine granulation extending over all annulations with but a slight tendency to become coarser on the axis.

Phacops correlator sp. nov.

Plate 2, fig. 9

1892. *Phacops* (*Acaste*) cf. *anceps* Clarke, op. cit. p. 412

This very interesting fossil I was at one time disposed to regard as identical with Phacops anceps of the Upper Helderberg limestone. On comparison with the original specimen, which was described and figured by the writer in volume 9, *Archivos do museu nacional do Rio de Janeiro.* 1890. p. 16, pl. 1, fig. 3, a difference appears, which will not permit the union of the forms, and this is found in the sharper development of the glabellar furrows. In Ph. anceps, the only known example of which is an internal cast of the cephalon in limestone, there is no trace of the first and second pairs of these furrows, but in Ph. correlator these furrows are quite clearly developed both on internal casts and impressions of the exterior. There is still a degree of uncertainty whether all these specimens may not prove to belong

to the same species; for in Ph. braziliensis, of the Maecurú Lower Devonic, another species very closely similar to Ph. anceps, the glabellar furrows may be all well displayed on the internal cast.[1]

The three species above mentioned are alike in the small size of the cephalon, having the same dimensions in all specimens observed, in the rounded genal angles, the firmness of the union of cranidium and cheeks, separated specimens being very unusual, the peculiar dalmanitiform aspect of the glabella and its slight median angulation, the small eyes and smooth surface. Though the other parts of the species are not known, yet the cephalon indicates the intermediate nature of these species between the genera Phacops and Dalmanites, and doubtless when the rest of the body has been found, it will express similar relations.

The existence of expressions of this type of structure in the Lower Devonic of the Amazons (Maecurú), of Cayuga, Ontario, at Becraft mountain and nowhere else, so far as known, is a fact of significance in the correlation of these faunas.[2]

Phacops logani Hall

Plate 1, fig. 1-5

1892. *Phacops sp. nov.* Clarke, op. cit. p. 412

In the notice above cited I suggested the similarity of the specimens of Phacops here found to Phacops logani of the Helderbergian and Ph. pipa of the Onondaga limestone. Restudy of the material has convinced me that the fossil is not to be distinguished from the former. Though the species is of frequent occurrence, the specimens are generally somewhat distorted cephala and pygidia, and few entire examples have been observed. Such distortion generally gives a too pointed, subpentagonal form to the glabella and a too narrow and elongate form to the pygidium. The characteristic traits of the species Ph. logani are these: the glabella is relatively narrow and strongly

[1] *See* Archivos do museu nacional do Rio de Janeiro. v. 9, pl. 1, fig. 1, 2.

[2] The writer has recently obtained specimens representing the same type of structure in the Gaspé sandstone at Gaspé Basin Quebec.

projacent at the front; its surface shows without compression both the oblique and transverse moieties of the first glabellar furrows and also the second furrows; the occipital ring is strongly arched and bears a conspicuous tubercle. On the axis of the thorax just within the dorsal furrows is a row of large tubercles, one at each end of every axial segment. These are not ornamental, but are more strongly marked on the internal cast than on the external surface; they become smaller posteriorly but on the cast show themselves even on the first segment of the pygidium. The pygidium bears five or six lateral segments, flat and divided by linear furrows which are generally obscure on the cast.

While these are the diagnostic characters, the species has some other traits which it shares with but few allies. There is a small spinule at the extremity of the cheeks, such as occurs in Ph. cristata and Ph. pipa of the Schoharie grit and Onondaga limestone; no spinules or conspicuous tubercles occur on the axis, such as are found in Ph. cristata but are absent in Ph. pipa. The division of the pleural ribs on the pygidium is a feature not displayed in the later Devonic species of the genus (e. g., Ph. rana).

The specimens from Becraft mountain have for the most part these characters of Ph. logani. Examples of the thoracic segments of adult forms have proved rather uncommon, but those seen have the rows of tubercles along the dorsal furrows well developed, while in smaller forms these are less conspicuous and may be so far absent as to suggest the possibility of there being a second species; and yet it is to be noted that these tubercles are less clearly developed in the later segments of Ph. logani and it may be are obscure in young examples of the species.

Cordania becraftensis sp. nov.

Plate 2, fig. 19–23

1892. *Cordania, sp. nov.*, Clarke, op. cit. p. 412

Of this species only the cranidia and pygidia are known. The former have a subcircular, marginal curve, with a round, thickened and much elevated border which is clearly delimited within and is followed by a relatively narrow and shallow depressed area passing into the con-

vexity surrounding the glabella. The latter is ovoid, convex and large extending two thirds the length of the cephalon. Its anterior extremity is rather broad and blunt, and at its base are two subtriangular or ovoid lobes set off from the glabella by deep, oblique furrows. The other glabellar furrows manifest themselves in the manner characteristic of this genus, the first pair making a broad indentation just in front of the middle, very noticeable on the internal cast, and the second pair being extremely obscure. The ornamentation of the head consists of very fine pustules with larger ones scattered among them. This character is maintained over the glabella to the frontal margin, where the coarser pustules disappear, leaving the surface here with a very fine granulation, and on the doublure this is replaced in part by punctation.

Pygidium subcircular, axis very convex, incurving toward the extremity. The annulations are narrow and not direct, but rise nearly vertical from the dorsal furrows or with a slight forward inclination, then, at less than one third of their length, bend forward with a distinct angulation curving anteriorly over the median line. These annulations are nine, and beyond the last that is well defined may be counted three more obscurely defined. The interannular grooves are narrow. The pleurae are broad, convex about the median region, becoming depressed toward the margin, sometimes defining a narrow border. The ribs are seven, rather broad, obscurely grooved for most of their length by a linear sulcus which becomes well marked on the border and gives the ribs the appearance of being bifurcated. The intervening furrows are narrow. The ornamentation consists of fine, uniform tubercles on all annulations, with a single axial row of strong, spinous tubercles directed posteriorly.

This species, in its general aspect and comparatively large dimensions, approaches Cord. cyclurus H. and C. of the Helderbergian much more nearly than it does any of the later species, which are uniformly smaller and differently ornamented. In Cord. cyclurus the cephalon has a few coarse tubercles on the border, and over the concave area between the border and the glabella are fine, inosculating furrows. The distance between the border and the anterior end of the glabella is less in Cord. cyclurus than in Cord. becraftensis. In

the former species also the pygidium has the axial row of tubercles smaller and duplicate toward the extremity, and lacks the fine granulation of the entire surface.

The species is not uncommon in this fauna.

Cordania hudsonica sp. nov

Plate 2, fig. 17, 18

A few pygidia show the presence of a quite distinct species of this genus. They are of small size, broad and quite short, the axis covering about one third the width of the shield, somewhat flattened and not incurved as in Cord. becraftensis and Cord. cyclurus. They bear eight or nine narrow, transverse annulations which show no angulations. The pleural ribs are six, with a trace of a seventh, are quite narrow, with interannular furrows of equal width. They are divided by quite deep sulci, and the surface carries a few scattered tubercles.

Cyphaspis minuscula Hall (sp.)

Plate 2, fig. 24, 25

1888. *Cyphaspis minuscula* Hall and Clarke, *Paleontology of New York.* 7:140, pl. 20, fig. 17; 24, fig. 7–12

1892. *Cyphaspis sp. nov.*, Clarke, op. cit. p. 412

Cranidia of this species, distinguished from the closely allied Cyphaspis coelebs H. and C. of the Helderbergian by the low median angulation of the glabella, are not of infrequent occurrence. Pygidia referable to the species have also been observed.

Cyphaspis minuscula is quite widely distributed in the Onondaga limestone of New York, and our present knowledge leads to the belief that it may not be easy to fix on a genuine specific difference between it and the Helderbergian form. The latter is exceedingly rare, and but two very unsatisfactory specimens have been seen. The feature above cited is the only one which could now be indicated as distinctive. Both however are sufficiently unlike the other Devonic species of the genus, and represent a type characterized by the absence of any peculiar arrangement of tubercles, spines or punctae on the surface, the exterior being smooth or very finely granular.

Proetus conradi Hall

Plate 2, fig. 11-16

1861. *Proetus conradi* Hall, *Descriptions new species of fossils.* p. 69

1892. *Proetus sp. nov.? A; Proetus, sp. nov. B,* Clarke, op. cit. p. 412

Separated cranidia and pygidia of a species of this genus are sufficiently common and these vary greatly in size. Though some of them attain much greater dimensions than any specimens of Proetus conradi, yet they all seem to agree in structure among themselves and with typical examples of that species from the Schoharie grit. Specific distinctions among such Devonic forms of this genus as express the old division Gerastos, and are represented in the New York series by P. angustifrons, conradi, clarus and rowi, are pretty close and yet dependable. The special traits of Proetus conradi are its subovoid or subtriangular and quite convex glabella, tangent at its extremity to the inner margin of a flat frontal border, and a pygidium with sloping pleurae bearing three or four rather indistinct duplicate ribs, the axis having from 8 to 10 annulations which curve backward along the median line.

But a single entire example of the species has been observed and this is of medium size, attaining the proportions usual to species of this type throughout the early Devonic faunas.

Acidaspis tuberculata Conrad

Plate 2, fig. 26

1840. *Acidaspis tuberculata* Conrad, *Ann. rep't geol. sur. N. Y.* p. 205

This species, common in certain layers of the New Scotland beds, is here represented by specimens of various sizes, often attaining considerable dimensions.

Lichas cf. pustulosus Hall

1859. *Lichas pustulosus* Hall, *Paleontology of New York.* 3:366

There have been found a few fragments of pygidia and other parts of the test which may prove to belong to this Helderbergian species.

Homalonotus sp?

We have previously recorded the presence of this genus as represented by a few patches and fragments of the test. Their specific characters can not be made out. The genus, however, is to be expected from the fauna, as it is represented by a species of commanding proportions, H. major Whitfield, from the same horizon, near Marbletown, Ulster county.

CIRRIPEDS

Plumulites sp.

A single plate shows the presence in the fauna of this genus of cirriped crustaceans.

ANNELIDS

Conodonts

Annelid teeth of this character have been observed but not in suitable condition for identification.

Autodetus beecheri Clarke

Plate 2, fig. 27–32

1892. *Autodetus sp. nov.*, Clarke, op. cit. p. 411

1894. *Autodetus beecheri* Clarke, *Amer. geol.* 13:334, fig. 7–19

This species is quite abundant, and young shells showing the primary revolutions of the whorls are commonly found attached to the surfaces of brachiopods and spreading bryozoa. There is some variation in the aspect of the body at maturity, and though the form is generally a truncated obcone, sometimes there is little difference in the diameter of the basal cicatrix and that of the final whorl. Generally, too, the surface, rough and wrinkled, conceals all trace of the sutures, but at times these are clearly shown by the annulated exterior of the shell.

Spirorbis assimilis, sp. nov.

Plate 2, fig. 33–34

1892. *Spirorbis sp.* Clarke, op. cit. p. 411

Tube small, regularly coiled, not free on final whorl, all coils attached and by their sinistral surface. Inner whorls nearly concealed; number

of exposed whorls 2–3. Exterior of outer whorl with a low, revolving lateral carina, which gives the upper surface a flattened aspect; otherwise the surface is smooth.

This species is distinguished from young forms of Autodetus beecheri, in which the Spirorbis condition is completely inclosed in the later growth of the shell, by the much less depth of its whorls and the greater transverse diameter of the shell.

Cornulites cingulatus Hall

Plate 2, fig. 35–38

1888. *Cornulites cingulatus* Hall, *Paleontology of New York.* v. 5, pt 2 (= 7, suppl.) p. 20, pl. 116, fig. 29

The original of Corn. cingulatus is from the Helderbergian (New Scotland beds) of New York, but its precise locality is not recorded. It occurs occasionally in the Oriskany, where it presents a rapidly expanding tube with coarsely and rather irregularly rugose surface, the wrinkles being crossed by fine but sharp vertical striae. On the internal cast the annulations have the aspect of insheathed cones and are not unlike such casts of large Tentaculites, though of much less regular arrangement.

Tentaculites elongatus Hall

Plate 3, fig. 8–12

1859. *Tentaculites elongatus* Hall, *Paleontology of New York.* 3:136, pl. 6, fig. 16–21

1892. *Tentaculites* cf. *elongatus* and *Tentaculites sp. nov.*, Clarke, op. cit. p. 413

The specimens of this species, described from the Helderbergian (New Scotland) limestone of the Schoharie section, are not infrequent throughout the Oriskany. Many of them show finely the sharp, filiform, concentric striae which cover annulations and depressions alike. Approaching the apex of the shells, the surface gradually loses its annulations but retains the concentric striae; for some distance the apical region is quite free of any trace of annulations and where this part is found by itself it presents the aspect of a quite distinct species. The internal cast of the species was well characterized by Hall as resembling a series of truncated obcones one above the other; thus these casts are altogether unlike the exterior of the species.

Tentaculites? acus, sp. nov.

Plate 3, fig. 1-7

1892. *Coleolus sp.?* Clarke, op. cit. p. 413

Shells having as large size as those of Tentac. elongatus but with the exterior surface smooth or with very faint, distant, broad, concentric depressions and fine, indistinct and somewhat irregular growth striae. The internal cast is similar to that of Tentac. elongatus but has the constrictions less deep. Specimens of this species are not uncommon.

The wall of this species is thick and cellular, and a transverse section gives two or more concentric circles at any plane, showing the insheathment of the funnel-like divisions of the interior. This structure is much more pronounced than in any species of Tentaculites observed by the writer and, though more regular than in Cornulites, may prove to be of the same nature.

PTEROPODS (?)

Conularia cf. desiderata Hall

1857. *Conularia desiderata* Hall, *Paleontology of New York.* 3:480, pl. 72a fig. 4

A single fragment of medium size, bearing a clearly exposed septum, approaches this species, described from the Oriskany elsewhere in New York. Its surface characters are sufficiently preserved to demonstrate the broad sulci at the angles and the absence of median furrows on the four sides, but the detailed sculpture of the concentric lines is not clearly retained.

GASTROPODS

Bellerophon sp.?

A single specimen shows the inner whorls of a broad backed species.

Cyrtolites expansus Hall

Plate 3, fig. 20-23

1859. *Cyrtolites? expansus* Hall, *Paleontology of New York.* 3:479, pl. 104, fig. 4, 5

1892. *Cyrtolites expansus* Clarke, op. cit. p. 413

The original figures and description of this shell from the Oriskany sandstone of New York were evidently based on internal casts, and

were, hence, not altogether satisfactory for identification. Specimens of this genus in the fauna under consideration are of not inconsiderable size and seem to represent but a single species, characterized: 1 by the sharp, concentric lamellae of the surface; 2 by the broadly expanded aperture; 3 by the well defined median ridge on the earlier parts of the shell, on which the striae have a pronounced retral bend, the ridge becoming obsolete at the margin. The specimens have the proportions and curvature of Cyr. expansus, and two of the figures cited (4a,b) show evidence of the concentric markings and the definition of the median ridge. Squeezes from casts of the exterior show a very fine radial striation between the concentric lines. The apertural slope beneath the coil bears a broad median sinus bounded by low, divergent ridges which modify the peristome.

The species is not uncommon.

Pleurotomaria sp.

A single specimen of this genus has served as the surface of attachment for a large colony of Fistulipora, and before this coral began its growth the shell had become more or less covered with Spirorbis and Hederella. Thus, while its form is preserved without distortion and the slit-band is clearly shown, the character of its ornament can not be made out, and it is unwise to attempt a definition of the specific characters.

Diaphorostoma desmatum, sp. nov.

Plate 3, fig. 13–19

1892. *Diaphorostoma sp. nov.*, Clarke, op. cit. p. 413

Prof. Hall embraced within the species Diaph. ventricosum a series of small shells which are associated with the large, normal form of that species, regarding them as young stages. Similar shells are found very abundantly in the Becraft mountain Oriskany, and we find from a careful examination of the best external casts obtainable that there is a difference in the two in respect to superficial characters; for, while in the large and ventricose shells the lineation consists of crowded, concentric growth lines which become wrinkles on the last whorl and seem

to be to a large degree the cause of the irregularities in contour often displayed by full-grown shells, the smaller form has these concentric growth lines more sharply defined and elevated, and these are covered by equally fine and sharp interrupted revolving striae, which together produce an effect similar to that exhibited by the common Hamilton species, D. lineatum Conrad. These revolving lines seldom cancellate the concentric erect lines, but profoundly modify their interspaces.

In general form these shells do not widely differ from the early whorls of D. ventricosum, but their abundance and uniformity of size in addition to the characters indicated seem to establish a specific difference.

Diaphorostoma ventricosum Conrad

Plate 3, fig. 25–28

1892. *Diaphorostoma ventricosum* Clarke, op. cit. p. 412

For other figures see *Paleontology of New York.* v. 3, pl. 112, fig. 1–10; 113, fig. 7, 8; 115, fig. 8

This species is the most abundant of all the gastropods and attains normal size and proportions, though usually the large ventricose body whorl has been crushed.

Strophostylus expansus Conrad

Plate 3, fig. 24

1892. *Strophostylus expansus* Clarke, op. cit. p. 412

For other figures see *Paleontology of New York.* v. 3, pl. 114, fig. 2, 3a, b

A single well defined example of this shell has been observed.

Orthonychia tortuosa Hall

1892. *Platyceras tortuosum* Clarke, op. cit. p. 412

For figures see *Paleontology of New York.* 3:472, pl. 113, fig. 1–5

This species is not common, and no well-preserved examples have been seen.

Platyceras cf. gebhardi Hall

Plate 3, fig. 29

Platyceras gebhardi[1] was described from the Oriskany of

[1]Paleontology of New York. 3:474, pl. 117, fig. 1–10.

Cumberland Md. A single specimen having similar characters has been observed in the Oriskany of Becraft mountain, and this shows a slight departure from the type in the flattening of the outer surface of the body-whorl.

Platyceras nodosum Conrad

1892. *Platyceras nodosum* Clarke, op. cit. p. 412

For figures see *Paleontology of New York.* v. 3, pl. 115, fig. 1–6; 116, fig. 1–4

This species, common in the Oriskany sandstone of Albany and Schoharie counties, is occasionally represented in the Becraft mountain fauna.

LAMELLIBRANCHS

Pterinea sp.?

(Cf. *Megambonia lamellosa* Hall, *Paleontology of New York.* 3: 467, pl. 109, fig. 5, 6)

Large but incomplete left valves indicate the presence of a species without radii but with a smooth surface showing only concentric growth lines. One of these exposes a part of the right valve, which has a depressed convex and similarly smooth surface. The outline of these shells can not be clearly made out, but they present the proportions and to some degree the aspect of the species cited.

Pterinopecten subequilateralis Hall

Plate 4, fig. 14

1859. *Avicula subequilateralis* Hall, *Paleontology of New York.* 3: 281, pl. 49, fig. 6

Prof. Hall described this species from a single valve from the Pentamerus (Coeymans) limestone in Schoharie county. The form is peculiar and interesting from its subsemicircular, nearly equilateral form and its smooth exterior. The original referred to was regarded as a left valve, but our specimens seem to demonstrate that it is the opposite valve. This right valve is convex with a long, straight hinge which makes the greatest diameter of the shell. The anterior and posterior wings are not distinctly set off from the body of the shell, but the former is the larger and is defined by a deeper concavity of the surface. The

notable convexity of this right valve and the absence of byssal sinus beneath the anterior wing are features which suggest the subgenus Vertumnia Hall.

The surface is without any trace of radial marking, but bears frequent though rather obscure concentric lines of growth. The species is rare, and the left valve has not been observed.

Pterinopecten proteus, sp. nov.

Plate 4, fig. 4–8

Shell of medium or large size, subcircular in outline with anterior and posterior wings well developed. Left valve normally convex, right valve slightly convex or depressed. Hinge-line straight and making the greatest width of the shell.

Surface marked by an ornamentation quite variable in its expression. A few stout ribs depart from the beak and maintain their individuality to the margin, becoming broader and somewhat flattened as they extend outward. The intervals between these ribs are broad and in occasional instances are but rarely divided by minor ribs. As a rule, however, these interspaces carry one, rarely two secondary ribs, which are implanted and not produced by dichotomy, and these lesser ribs maintain their minor character throughout, very seldom attaining the size on the margin, of the primary ribs. The mode of increase of these ribs is such that no tendency to their fasciculation is manifested. The variable size and number of the intermediary ribs, however, give each specimen an appearance in this respect unlike all others. The radii are crossed by fine, elevated lamellae, which are moderately and equally distant over the upper and median parts of the shell, but become closely crowded near the margins. These cancellate all radii. On the right valve there is notable variation in the size of the primary ribs, but no ribs which are distinctly intercalary except over the anterior slope. Concentric lines are also present, and these may become lamellae over the peripheral regions, in which case they may obscure the ribs and produce an approximately smooth surface. Specimens of both valves have been observed on which the predominance of the concentric lines almost obliterates the radii, specially on internal casts. This, however, is not

complete, the casts generally showing obscure nodes on the radii where these have been crossed.

Prof. Hall describes as Avicula recticosta a single right valve from the Oriskany sandstone of Albany county, characterized by its strong ribs, which are said to proceed in pairs from the umbo and to dichotomize; in these respects that shell is unlike those with which we are here dealing.

This is the most abundant of the lamellibranchs of this fauna. In its general features it may be brought into comparison with several of the Ulsterian and Hamilton species, but its specific traits are distinct and pronounced.

Pterinopecten signatus, sp. nov.

Plate 4, fig. 3

Shell of medium size, obliquely suboval. Hinge-line straight and long, not exceeding the greatest diameter of the valves. Anterior ear strongly developed and nasute; posterior of moderate size not sharply set off from the body of the shell. On the left valve the byssal depression is strong, the surface normally convex. The ornament of this valve consists of narrow, filiform subequidistant radii, increasing by implantation, the first of the minor series generally attaining on the margin the full size of the primary series. The interspaces are broad, free and subequal on the margins. These radii cross both wings, but are obscure on the anterior. Fine, erect concentric lines cross all radial lines; toward the edges these become crowded, lamellose and overlap each other. The right valve is depressed convex or flattened and bears radial striae, but the concentric lines are obscure or wanting except on the wings.

This rare species is readily distinguished from Pt. proteus by its fine, regular and uniform radii. It resembles the Onondaga species Pt. terminalis, but not closely. Pterinopecten bellulus of the Helderbergian is unlike it in having dichotomous and fasciculate radii.

Pterinopecten pumilus, sp. nov.

Plate 4, fig.

The sole example observed of this species is a right valve of very

small size and quite considerable convexity. The beak is subcentral, the outline and contour slightly oblique and the wings not distinctly separated from the body of the valve. The surface bears from 40 to 50 fine radii, the majority of which arise by dichotomy over the median parts of the valve, but all have about the same size and are equidistant on the margin. These are crossed by extremely fine, concentric lines and a few obscure undulations.

The convexity of this valve shows the relation of the species to those later Devonic shells which have been referred by Hall to the subgenus Vertumnia.

Aviculopecten sp.?

A small right valve of orbicular outline has deeply concave wings and a depressed surface with extremely faint and fine radii.

Lyriopecten sp.?

An imperfectly retained right valve has very obscurely defined wings, the anterior wing not interrupting in any way the convexity of the shell. The surface is cancellated by fine radii in several series, crossed by concentric, erect lines.

Actinopteria communis Hall

Plate 4, fig. 1, 2

1859. *Avicula communis* Hall, *Paleontology of New York.* 3:286, pl. 51, fig. 1–7; 53, fig. 4, 6

To this species is referred a shell which attains the size of average specimens of Actinopt. communis and is ornamented by radii of alternate or unequal size, crossed by low, concentric erect lamellae. On the anterior surface of the left valve these striae produce a sharp cancellation and on the large and flat posterior wing radial and concentric lines are of about the same size. On the right valve the wing is cancellated but on the body of the shell the concentric lines are absent, and the radii are distant and not alternate. This rare shell in the Oriskany seems to agree with the characters of Actinopt. communis of the Helderbergian, though it also approaches the Actinopt. textilis Hall of the same fauna.

Actinopteria insignis sp. nov.

Plate 4, fig. 10–13

In form and proportions this shell resembles a young Actinopt. communis, but its habit is always small and its exterior profoundly cancellated. It is oblique, with large and much depressed posterior wing and small but nasute anterior wing, separated from the body of the shell by a broad sulcus distinctly extending to the umbo. The principal radial striae are strong and rounded, each interspace bearing from one to three very much smaller ones, making a more marked contrast in the size of the radii than is exhibited by the species Actinopt. communis. These lines are crossed by close concentric lamellae cancellating the entire surface, though both series of lines are quite obscure on the posterior wing. To a certain degree this shell presents in miniature the characters of the species Actinopt. textilis, which is mainly distinguished from its associate, Actinopt. communis, in the stronger cancellation and interruption of the radii.

The species is not uncommon.

Goniophora sp.?

This genus is represented by an incomplete valve showing a pretty strong posterior carination and quite regular concentric plications which become broader posteriorly.

Megambonia crenistriata, sp. nov.

Plate 4, fig. 15–17

1892. *Megambonia bellistriata* Clarke, op. cit. p. 413

Megambonia bellistriata Hall, of the Helderbergian, and M. cardiiformis Hall, of the Onondaga limestone are shells in which with present knowledge it is difficult to find a specific difference. The Megambonia occurring in the Oriskany of Becraft mountain approximates this specific type, but is distinguished therefrom in the following features: it is a persistently smaller shell, none of the observed specimens approaching the dimensions normal to those forms; again, it is shorter and lacks the strongly ovoid contour of the others, a feature specially marked in early stages, where the form was decidedly

transverse; the byssal groove is profound from the umbo down, and the auricle sharply convex.

The entire surface is covered with fine, elevated radial striae of subequal size and separated by grooves of the same width. Over the auricle and adjoining surface the striae are coarser and are crossed by strongly cancellating concentric lines, which produce projecting processes on the radii, in places taking the form of small spinules. Low varices of growth occur at irregular intervals.

Cypricardinia indenta Conrad

Plate 4, fig. 18-20

1892. *Cypricardinia* cf. *lamellosa* Clarke, op. cit. p. 413

For figures of *C. lamellosa* see *Paleontology of New York.* v. 3, pl. 49a, fig. 50 a-c; of *C. planulata* and *C. indenta*, op. cit. v. 5, pt 1, pl. 79, fig. 1-23

The specific type of Cypricardinia lamellosa Hall, described from small specimens from the shaly (New Scotland) limestone, is continued upward into the Onondaga and Hamilton faunas. The figured examples of the C. planulata of the Schoharie grit show a shell of very large size, possessing the characteristic lamellate surface, but associated with it is a small shell of rather different outline, which it will be difficult to separate from C. lamellosa. Cypricardinia indenta occurs both in the Onondaga limestone and Hamilton shales. Internal casts of these shells, the usual condition in which they are found, show some slight difference in the character of the broad, concentric ridges of the surface; but, when the exterior is retained, it appears to be in all cases without material variation in the form, contour and size of the shell (C. planulata excepted). The shells occurring in the Becraft mountain Oriskany are of this persistent type, of medium size, with strong posterior ridge and postcardinal depression, with six to eight concentric lamellae, which are broad and free at the edges and have their surface sculptured by fine lines, radial on the postcardinal slope but en chevron over the umbonal ridge, again becoming radial toward the middle of the shell.

The species is represented in our collections by about a dozen specimens.

Conocardium inceptum Hall (?)

Plate 4, fig. 21-23

1857. *Conocardium inceptum* Hall, *Paleontology of New York.* 3:491

Shell small, obliquely triangular, anterior slope abrupt, posterior surface moderately extended. The heart-shaped anterior surface is somewhat convex at first but becomes depressed nearer the margin. The median portion of the valves is prominent, somewhat oblique anteriorly, and its crest is ridged by the remnant of the anterior expansion. The posterior is concave medially, the extremities of the valves being turned upward.

External surface marked by fine, sharply elevated radial plications in a primary and secondary series, the members of each being of about equal size. These are crossed by finer, concentric erect lamellae making a deep cancelation of the exterior. On internal casts the surface appears to bear ribs of which five or six in the posterior region are broad and separated by narrow furrows; over the middle of the valves the ribs are much narrower, eight or 10 in number, and the intervening furrows are broad, sometimes showing traces of intercalary ribs in each. On the posterior slope the ribs become broader again.

The original description was based on very incomplete material, unaccompanied by figures. So far as can be ascertained the Oriskany shell is identical with this Helderbergian species. The aspect of the plication in internal casts is not unlike that of some of the small examples of Conocar. cuneus var. nasutum Hall, of the Schoharie grit[1] and particularly that of Conocar. concinnum Hall of the Hamilton shales[2] to which it corresponds in size, but we are not yet fully acquainted with the exterior of these shells. Average length and width of shell, 10 mm.

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[1]*See* Paleontology of New York. v. 5, pt 1, pl. 67, fig. 13.

[2]Pl. 68, fig. 26, 27.

BRACHIOPODS

Oriskania sinuata, sp. nov.

Plate 5, fig. 9–12

1892. *Centronella sp. nov.*, Clarke, op. cit. p. 414

Shell of comparatively large size, elongate ovate in outline. Lateral commissure sigmoid. Pedicle-valve convex, strongly ridged medially, with sharply sloping sides. Beak prominent, arched and so incurved as largely to conceal the deltidial plates. Brachial valve flat in the umbonal region. A low median sinus begins at about the center of the valve, becomes wider and deeper over the pallial region and makes a strong linguate depression on the anterior margin. On the interior the brachial valve bears the strong cardinal plate and process peculiar to this genus, and shows deep adductor impressions and pronounced vascular sinuses over the pallial region.

This shell, which sometimes attains the proportions of Oriskania navicella Hall and Clarke of the Oriskany sandstone at Rondout and Knox, differs from that species in its deeply sinuate brachial valve.

Cryptonella (?) fausta, sp. nov.

Plate 5, fig. 1–8

1892. *Cryptonella, sp. nov.*, Clarke, op. cit. p. 414

Shell of medium size, elongate oval, commissure nonsinuate. Valves inequiconvex or subequiconvex. Beak of pedicle-valve generally erect and prominent, with well developed cardinal slopes, sometimes arched, partially concealing the deltidial plates. Surface of the pedicle-valve convex, sometimes with a broad median prominence which adds to the convexity; sides gradually sloping; anterior margin nonsinuate. Brachial valve somewhat less convex, slightly depressed in the pallial region; in some specimens ridged medially in the umbonal region.

Interior of the pedicle-valve with muscular scars, obscure vascular sinuses and dental plates developed into a short spondylium.

Surface generally smooth; sometimes with traces of obscure plications about the margins.

The shells included under this name may with more material be found to embrace two distinct forms, those having nearly equiconvex valves and those in which the pedicle-valve is the deeper and distinctly ridged medially. The

latter have the expression of Centronella more pronounced, while the former suggest the genus Cryptonella. The former also have the beak of the pedicle-valve the more erect. These two expressions, however, seem to grade one into the other. One of the equiconvex shells retains a portion of the interior of the brachial valve and shows the principal part of the loop. There is an elongate hinge-plate which is perforate, and from its anterior edge descend parallel or slightly divergent loop branches which are reflected and upturned at their extremities as though to form an ascending curve, but if this upward branch existed it has been broken off, as frequently happens in Cryptonella. The aspect of the apparatus is like that of the genus mentioned, save in this respect, that the descending branches are cemented for their entire length to the apparent floor of the valve. Both replaced shell and loop are retained in silica and it seems probable that this attachment is wholly due to excessive deposition of this substance. The species is not of infrequent occurrence. There is an undescribed shell of very similar character to this in the New Scotland limestone.

Cryptonella, sp. nov.

This species is represented by two imperfect specimens of a large, convex pedicle-valve whose width is equal to or greater than its length. The surface is somewhat elevated medially in the unbonal region of one of the specimens, while in the other the valve is full and rounded. Umbones depressed; beak not conspicuous, erect. Surface highly punctate with very low and fine radial plications. On the interior the dental lamellae unite to make a short but slightly elevated spondylium, in front of which is a short median septal plate. Length of the valve 17 mm; width 21 mm.

Rensselaeria ovoides Eaton

Plate 5, fig. 17–19

1892. *Rensselaeria ovoides* Clarke, op. cit. p. 414

For other figures see *Paleontology of New York.* v. 3, pl. 104, 105; v. 8, pt 2, pl. 75

Typical examples of this characteristic Oriskany species are quite common in these beds.

Megalanteris ovalis Hall

Plate 5, fig. 13–16

1892. *Rensselaeria suessana?* and *R. ovalis* Clarke, op. cit. p. 414

For other figures see *Paleontology of New York.* v. 3, pl. 106; v. 8, pt 2, pl. 77, fig. 12–22

Specimens are commonly found showing considerable variation in outline, but well characterized in all specific details.

Eatonia medialis Vanuxem

1892. *Eatonia medialis* Clarke, op. cit. p. 414

For figures see *Paleontology of New York.* v. 3, pl. 37, fig. 50, a–y; v. 8, pt 2, pl. 61, fig. 29–35

A few incomplete specimens indicate the presence of this Helderbergian species in the Becraft mountain Oriskany.

Eatonia peculiaris Conrad

1892. *Eatonia peculiaris* Clarke, op. cit. p. 414

For figures see *Paleontology of New York.* v. 3, pl. 38, fig. 21–26; 101, fig. 2; v. 8, pt 2, pl. 61, fig. 17–26

Normal examples of this species are occasionally found. It is a well known species of both the Helderbergian and Oriskany faunas.

Camarotoechia barrandii Hall

1892. *Rhynchonella barrandii* Clarke, op. cit. p. 414

For figures see *Paleontology of New York.* v. 3, pl. 103, fig. 3–8

Specimens of the Rhynchonellas observed in these beds have proved to be very unsatisfactory for study and for the most part, for identification. A part of a large interior of the pedicle-valve, attaining the full proportions of the figures of the species given in the work cited, is safely referred to this species; and a few other specimens with less security.

(?) Camarotoechia fitchana Hall

For figures see *Paleontology of New York.* v. 3, pl. 101, fig. 1, a, b

A large but imperfect brachial valve bearing about 75 obliquely angular ribs is referred with reserve to this species.

Camarotoechia oblata Hall

Plate 5, fig. 22

For figures see *Paleontology of New York.* v. 3, pl. 102, fig. 1, 2

A number of large shells possess the numerous sharp, simple ribs of this species, with its low fold and shallow sinus bearing 10 to 14 of the plications. The distinction between C. oblata and C. pliopleura Conrad is not well marked in these shells.

Camarotoechia dryope Billings (sp.)

Plate 5, fig. 20, 21

1874. *Rhynchonella dryope* Billings, *Geol. sur. Canada; Paleozoic fossils.* v. 2, pt 1, p. 37, pl. 3, fig. 1, a–c

A well preserved shell, silicified without distortion, has a sharply elevated median fold and sinus and angular plications, of which there are four on the fold, three on the sinus and five or six on each lateral slope. The general aspect of the exterior is shown in the figures on plate 5.

On comparison of this species with the figures of Rhynchonella dryope given by Billings there seems excellent reason for regarding the forms as identical. The Canadian shell is from Gaspé, limestone no. 8, to the character of whose fauna special reference is made on a subsequent page.

Camarotoechia, sp?

This shell, of which several distorted specimens have been observed, is of about the same dimensions as the preceding species, but its fold and sinus are less prominent and not angular in front. The ribs are more numerous and not angular but rounded, there being five or six on the fold and sinus and seven or eight on the lateral slopes.

Anastrophia, sp. nov.

The collections contain a single crushed internal cast of an Anastrophia, unlike described species in the very fine plication of the surface. It bears eight ribs on the median fold and 16 on each lateral slope. The genus has not before been recorded from horizons above the Helderbergian.

Coelospira concava Hall

Plate 5, fig. 23–26

1892. *Coelospira sp.*, Clarke, op. cit. p. 413

For figures see *Paleontology of New York.* v. 3, pl. 38, fig. 1–7; v. 8, pt 2, pl. 53, fig. 20–23

This little shell agrees in size and contour with the common Helderbergian species, but seems never to bear more than 12 plications, while in normal examples of the species the number may vary from 10 to 16.

The interior of the pedicle-valve bears a short median septum dividing two posterior muscular scars; at the middle of the valve it bifurcates and seems to inclose the impression of an anterior muscular pair, an arrangement similar to that seen in Coel. camilla of the Onondaga limestone.

This species is less common than Coel. dichotoma.

Coelospira dichotoma Hall

Plate 5, fig. 27–32

For other figures see *Paleontology of New York.* v. 3, pl. 103, fig. 3 a–c

Very abundant, occurring in large, well defined examples throughout the beds. This species is readily recognized both by its size, which at maturity is the largest attained by species of this genus, and by the duplication of its plications. The interior of the pedicle-valve shows a median septum extending for more than one half the length of the shell and dividing an elongate muscular area.

Leptocoelia flabellites Conrad

Plate 5, fig. 33–36

1892. *Leptocoelia flabellites* Clarke, op. cit. p. 415

For other figures see *Paleontology of New York.* v. 3, pl. 103b, fig. 1a–g; 106, fig. 1a–f; v. 8, pt 2, pl. 53, fig. 40–46, 53

The specimens of this species are in pretty close agreement with typical examples from the arenaceous Oriskany. A difference which is observable in all examples is a slight convexity of the brachial valve, specially pronounced on the anterior region by a deflection of that valve.

There is, farther, a notable breadth to many of the specimens, which is not so marked in normal individuals. Many of the examples emphasize the close approximation of this species to the Lept. acutiplicata Conrad, of the Onondaga limestone. This resemblance is particularly noticeable in the pedicle-valves, but the broader and more sharply angular plications of the latter species and the more depressed brachial valve constitute reliable differences. Prof. Hall, in 1867, pointed out the similarity of Lept. flabellites and L. acutiplicata, suggesting that the two might prove to be identical.

Trematospira multistriata Hall

Plate 6, fig. 1–4

1859. *Trematospira multistriata* Hall. *Paleontology of New York.* 3:209, pl. 24, fig. 3a–t; 28, fig. 5a–f

1892. *Trematospira multistriata* Clarke, op. cit. p. 414

(?) 1857. *Spirifer perforatus* Hall, *Descriptions of new species of fossils.* p. 60

1859. *Trematospira perforata* Hall, *Paleontology of New York.* 3:208, pl. 28, fig. 3 a–i; 8, pt 2, pl. 49, fig. 5, 6

According to the original descriptions, the distinguishing feature in the species above cited is the stronger fasciculation of the plications in T. perforata. It is noted also that in T. multistriata repeated duplication of the plications may occur. The specimens of Trematospira from the Oriskany agree in general features with the above species, though none have been seen which attain the size often reached by T. multistriata. The plications are sharply angular, with a broader, outer slope, specially near the median fold and sinus. These are sometimes simple throughout their course, but generally are duplicated at irregular intervals, the result of which is a strong fasciculation of the surface, the few early ribs which start at the umbones maintaining their prominence over the shell. This fasciculate effect is probably more pronounced in the majority of cases than is usual in normal specimens of Tremat. multistriata, but it would be impracticable to divide the Oriskany specimens on the basis of this character. On the other hand, their variation in surface characters serves to indicate the probable unity of those two Helderbergian species.

The surface is finely granulose and punctate.

Meristella lentiformis, sp. nov.

Plate 6, fig. 5–11

1892. *Meristella, sp. nov.*, Clarke, op. cit. p. 414

Meristella lenta Hall, is a diminutive species, which has been reported only from the Oriskany sandstone at Cayuga and De Cewville Ont.[1] It is of peculiar form, having the pedicle-valve broadly concave in the pallial region and the brachial valve highly convex medially, the sides sloping from this median prominence with a gently concave surface. In respect to this form, which is an extreme expression of a tendency frequently exhibited among the more equiconvex Meristellas, the species approaches the Meristella (Pentagonia) unisulcata Conrad, of the Onondaga and Hamilton beds. In the structure of the brachidium both of these shells have proved to be genuine Meristellas. The most abundant representative of this genus in the Becraft mountain Oriskany is a shell which nearly approaches Mer. lenta in contour, with some noteworthy differences, not the least being its considerable size. We may characterize the species as follows: shell unequally convex; outline transversely oval; pedicle-valve with short incurved beak and narrow cardinal slopes bordered by obtuse cardinal ridges diverging from the beak. Umbo slightly convex or flat, the surface sloping to the sides very gradually. A median sinus starts at the umbo and rapidly broadens, producing a general depression in the pallial region, which is rather sharply deflected. The sinus is produced into a linguate extension at the anterior margin. The general flatness of this valve is more marked in young shells, the anterior deflection becoming prominent with the increase of age. The brachial valve has a full beak curved into the delthyrium of the opposite valve, and is elevated medially into a broad ridge-like concavity terminating in a fold on the anterior margin. The lateral slopes are gently concave. The surface of both valves is smooth or bears only concentric growth lines.

On the interior the apophyses and impressions are those characteriz-

[1]For figures of this species see the original description, Paleontology of New York, 4: 420, pl. 63, fig. 19–22 and also v. 8, pt 2, pl. 44, fig. 15–18.

ing the genus. Particularly well developed is the broad, flabellate muscular scar of the pedicle-valve and the median septum of the brachial valve, extending for more than half the length of the shell.

The brachial valve resembles in its less extreme conditions that of the associated specimens of M. lata, but the shell taken in its entirety can not be confounded with any other species.

Meristella lata Hall

1859. *Meristella lata* Hall, *Paleontology of New York.* 3:431, pl. 101, fig. 3, a–m

1892. *Meristella* cf. *laevis* Clarke, op. cit. p. 414

The specimens which represent this species are of very much smaller size than the forms of this Oriskany shell which have been described, but they show no wide departure therefrom in other respects.

Meristella (?) vascularia, sp. nov

Plate 6, fig. 12–14

Among these fossils are frequently found internal casts of large pedicle-valves of an elongate Meristella-like form with broad median sinus developed over the anterior region. Notwithstanding that these specimens are not uncommon, I have not been satisfied of the character of the brachial valve to be referred to them, nor has it been possible to get a very clear conception of the exterior of the shells. These interior casts differ from that usual to Meristella in the following respects. Very prominent dental lamellae are developed by convergence and union into a strong spoon-shaped process, which fills the umbonal region and rests on the bottom of the valve, its anterior edge being free. The corresponding structure found in the Meristellas is of diminutive size compared with this. In front of this process lies the elongate, often obscure central muscular scar, which in Meristella is much more strongly developed and constitutes the most conspicuous feature of the interior. From the margins of the spondylium, even traversing the central scar, diverge strong radial grooves which cover the umbonal and median regions of the valve, disappearing about the margins. These features are uniform in all specimens, though the vascular lines are less conspicuous in young shells.

The exterior of the shell, preserved in part on one silicified specimen, bears low and distant radial striae, which are crossed by very fine and crowded concentric lines. Even with our present imperfect knowledge the species is clearly distinguished from all known Meristellas, but it is still far from certain that the shell is to be referrrd to this genus.

Spirifer arenosus Conrad

1892. *Spirifer arenosus* Clarke, op. cit. p. 413

For figures see *Paleontology of New York.* v. 3, pl. 98, 99, 100; v. 8, pt. 2, pl. 29, fig. 1–4; 30, fig. 3–7

Specimens of this characteristic Oriskany shell are not at all uncommon here and attain the considerable size and transverse form of the species as it occurs in the higher beds of this state. At Cumberland Md., and at Cayuga Ont., the species is generally much shorter on the hinge and more elongate medially, but this expression has not been observed among the specimens from Becraft mountain.

No complete account has ever been given of the nature of the surface configuration of this shell, and some of the fine external molds from the decomposed silicious limestone show the characters with exactitude. The plications are broad and distinctly flattened above, with very narrow interspaces, and the grooves bear the finest radial striations which are not interrupted by concentric lines. This is such a character as is seen on many of the upper Siluric Spirifers, but is not usual among the Aperturati till after the close of the Devonic.

Spirifer murchisoni Castelnau

Plate 6, fig. 26–30

1843. *Spirifer murchisoni* Castelnau. *Essai syst. silur. de l'Amér. septentr.* p. 41, pl. 12, fig. 1, 2

1859. *Spirifer arrectus* Hall. *Paleontology of New York.* 3 : 422, pl. 97, fig. 1, 2

1892. *Spirifer arrectus* Clarke, op. cit. p. 413

Characteristic specimens are very abundant throughout these beds. External molds display very perfectly the nature of the surface, which has never been quite accurately given. The broad, subangular ribs are

crossed by regularly concentric fimbriae of short spinules, and between these rows the surface is studded with granules so regularly arranged that they seem to have been produced by the breaking up of radial lines by intersections.

Very recently Dr H. Scupin has discussed the variations of this specific type occurring in the two Americas and South Africa[1] restricting the term Sp. arrectus to the forms figured by Hall in the work cited, excluding figures 1e and 1f on plate 97. From a consideration of these figures only it might seem that there is a varietal difference in the specimens here referred to, the one form having five or six lateral plications and a more prominent median fold, while the latter (fig. 1e and 1f) has seven or eight lateral plications, an apparently lower median fold, and seems to be a shell of larger habit. It would be a difficult matter to separate the specimens of this species occurring in the Oriskany sandstone on the basis of these features. The degree of plication is variable within the limits specified, and the prominence of the median fold as well as the apparent size of the shell dependent on the mode of retention. Determinations based on none too good illustrations and fortified mainly by the study of internal casts will not prove of practical usefulness in this case. Among the forms of this shell found in the Oriskany fauna the transitions from one expression to the other are so frequent as to make it practically certain that these differences are altogether fugitive.

I adopt without hesitation Castelnau's early term, Sp. murchisoni for this species, following Mr Schuchert's suggestion; for though the figures given by Castelnau are for the most part extremely obscure, no doubt can attach to his intentions and demonstration in this case.

In accordance with his determination, Dr Scupin proposes to restrict the term arrectus to shells represented in *Paleontology of New York* as cited, exclusive of 1e and 1f, and regards these identical with Sp. antarcticus Morris and Sharpe, a shell collected by Darwin in the Falkland islands. These he would term Sp. arrectus var.

[1]Ueber exotische, zur gruppe des Spirifer primaevus gehörige Formen; Zeitschr. der Deutsch. geol. Gesselsch, 1899. 50 : 462.

antarcticus, including therewith Sp. chuquisaca Ulrich (Bolivia), Sp. orbignyi Morris and Sharpe (Falkland Islands) and Sp. capensis v. Buch (South Africa). In view of the characters and variability of Sp. murchisoni in its typical localities it seems probable to the writer that a knowledge of all these lower Devonic shells (including Sp. hawkinsi Morris and Sharpe, Falkland islands) which is not so fully based on the characters of the internal cast, will prove them to belong for the most part to Sp. murchisoni.

Spirifer saffordi Hall

Plate 6, fig. 23-25

1859. *Spirifer saffordi* Hall, *Paleontology of New York.* 3:203, pl. 28, fig. 2, a-b

1892. *Spirifer* cf. *fimbriatus* Clarke, op. cit. p. 413

This is less common than either of the other species of Spirifer. Squeezes show that the low, sparse ribs are crossed by distant, concentric rows of greatly elongated, vertical spine-bases. These are produced both above and below the actual attachment of the spinules, the openings of the latter being seen at about the middle of each supporting ridge. From the position and direction of these hollow bases, it would seem that the spinules were either erect or inclined backward.

Metaplasia pyxidata Hall

1859. *Spirifer pyxidatus* Hall, *Paleontology of New York.* 3:428, pl. 100, fig. 9-12

1892. *Spirifer pyxidatus* Clarke, op. cit. p. 413

For figures see *Paleontology of New York.* v. 8, pt 2, pl. 39, fig. 19-22

This peculiar shell, which is common in the Oriskany at certain other localities, specially at Cayuga Ont., and is found also in the Onondaga limestone, is not of infrequent occurrence at Becraft mountain.

Cyrtina varia sp. nov.

Plate 6, fig. 15–22

1892. *Cyrtina rostrata* and *C.* cf. *dalmani* Clarke, op. cit. p. 414

The specimens of Cyrtina in this fauna are quite variable in size and proportions. There is a small, tetrahedral form with high, slightly concave and relatively short cardinal area, which suggests Cyr. dalmani Hall of the Helderbergian fauna, but is of larger size with narrower plications (5 or 6 on each lateral slope) and broader intervals. This form passes into one with very elongate cardinal area, like some of the forms from the Oriskany sandstone which have been regarded as young of Cyr. rostrata Hall.[1] There is again a large shell which sometimes attains the full size of Cyr. rostrata, with slightly arched, cardinal area and rather short hinge-line. These shells bear from 5 to 8 plications on the lateral slopes, have the median fold depressed or slightly furrowed on top, with a similarly flattened median sinus. The surface in all is finely pustulose and crossed by sharp, concentric lines. As there is at present no satisfactory basis for separating these various shells, and as they can not all be referred to any of the described species, they are here considered as individual expressions of the same species.

Chonetes hudsonica sp. nov.

Plate 7, fig. 1–6

1892. *Chonetes sp. n.*, Clarke, op. cit. p. 413

This is the only normally convex Chonetes found in this fauna. The shell is of medium or small size, transverse in outline; hinge-line marking the greatest width of the shell; lateral margins subparallel for a short distance and rounding rather abruptly to a nearly transverse anterior margin. Surface of the pedicle-valve quite uniformly convex, with a faint median sinus seen only over the anterior portion of the valve. The surface striae are fine, round and close together, with very narrow interspaces. They increase rapidly and irregularly by bifurcation and implantation. Very fine, concentric

[1] *See* Paleontology of New York. v. 3, pl. 96, fig. 1, a and b.

lines are sometimes visible with favorable preservation. The cardinal spines are two or three in number on each side of the beak and are directed outward.

On the brachial valve a fold to correspond to the obscure median sinus of the pedicle-valve is not always to be seen. So far as observed, the multiplication of the striae of this valve seems to be wholly by bifurcation. With respect to their interior characters, both valves present normal structure with a considerable development of the median septum in the pedicle-valve.

This species is quite common and is identical with or closely allied to a shell known to occur in the New Scotland limestone of the Helderbergian in Albany county.

The comparison of these shells with specimens of Ch. melonica from limestone no. 8 of the Gaspé series, at Grand Grève on the bay of Gaspé, Quebec, shows that the latter is a larger shell with a characteristic parabolic outline and a more profuse striation.

Ch. hudsonica however occurs in the Gaspé sandstones associated with Spirifer gaspensis, Leptostrophia blainvillii Billings, etc.

Chonostrophia complanata Hall

(=*Chonetes dawsoni* Billings, *Geol. sur. Canada; Paleozoic fossils*, 2:18. 1874)

Plate 7, fig. 1–13

1859. *Chonetes complanatus* Hall, *Paleontology of New York.* 3:418, pl. 93, fig. 1, a–d

1892. *Chonostrophia sp. n.* Clarke, op. cit. p. 413

This shell seems never to attain the size of the normal Oriskany form, but it has in general the same outline and seems to present no stable features on which a distinction from this species can be based. The striation of the surface is extremely fine and when well preserved is distinctly fasciculate, particularly about the beaks. Usually however this is more or less obscured over the body of the shell, the striae becoming subequal and often very faint. At times a still finer concentric striation is apparent. The reversed convexity is quite strongly

developed, perhaps more so than is usual with the upper Oriskany shell.

It is difficult to find any differences between this shell, specially in its smaller form and the Chonetes dawsoni Billings from the Gaspé sandstones. Both forms are but slight departures from the normal large expression of the shell depicted in the original illustration of C. complanata.

Between this species and the Chonostr. helderbergia Hall and Clarke of the Helderbergian, there seems but little difference except in the more uniform striation of the latter and its slighter convexity, but in the Chonostr. reversa Whitfield, of the Onondaga the differentials are the distinctly fasciculate striation, the elongate rather than transverse form and the diminutive size.

Anoplia nucleata Hall

Plate 7, fig. 14

1859. *Leptaena? nucleata* Hall, *Paleontology of New York.* 3:419, pl. 94, fig. 1 a–d

1892. *Anoplia nucleata* Clarke, op. cit. p. 413

For other figures see *Paleontology of New York.* v. 8, pt 1, pl. 15, fig. 17,18 and pl. 20, fig. 14–17.

This little species is far more abundant here than in the arenaceous Oriskany of New York. It occurs also in some abundance in rocks referred to the Oriskany in Jones county, Illinois.

Orthothetes becraftensis sp. nov.

Plate 7, fig. 15-28

Shell small, suborbicular or elongate in outline. Pedicle-valve erect at the beak, umbonal region generally sloping directly or with low convexity to the peripheral margins; sometimes slightly depressed about the umbo. Brachial valve depressed at and about the beak, becoming convex over the median and anterior regions.

Surface of both valves covered with strong, rounded striae increasing by implantation, new striae generally appearing in successive cycles. The surface also bears exceedingly fine, concentric lines which

are visible in the interspaces but seldom cross the radial striae. Concentric varices of growth are also frequent, specially near the margins.

The cardinal area of the pedicle-valve is triangular, broad and erect, seldom showing distortion. In but a single instance has attachment been observed and that is the young shell figured on plate 7, which adheres by its entire outer surface to a valve of Meristella and is associated with Autodetus, Hederella and some other parasitic growths. The deltidium is pronounced. On the interior the markings are those characteristic of the genus; the brachial valve bears an erect, continuous cardinal process, divided into two lobes, each grooved on its outer face. The lateral walls of this process are continued inward to form the strong dental sockets.

This very common species has no close ally in the Devonic faunas of the neighboring region. The Orth. woolworthana and Orth. deformis of the Helderbergian are large shells with a much finer surface striation, and perhaps the nearest approach is found in the Orth. arctostriata of the Hamilton shales, from which a difference will be found in outline and character of surface. Most closely allied also to O. becraftensis is an undescribed species in the Gaspé sandstone.

Hipparionyx proximus Vanuxem

1842. *Hipparionyx proximus* Vanuxem, *Geology of New York; rep't on third dist.* p. 124, fig. 29, no. 4

1892. *Hipparionyx proximus* Clarke, op. cit. p. 413

The specimens of this well known Oriskany species which have been obtained are of large size and characteristic in all details.

Stropheodonta lincklaeni Hall

Plate 7, fig. 37

1859. *Strophodonta lincklaeni* Hall, *Paleontology of New York.* 3:415, pl. 93, fig. 2, 3

1892. *Stropheodonta lincklaeni* Clarke, op. cit. p. 413

This species was not originally very clearly defined on account of the imperfection of the material, but the name has been generally applied to plane or slightly convexo-concave stropheodontids with a very

finely radiate surface. Indeed the exterior appears at first view to be almost smooth and shows numerous concentric growth-lines, but fine striae are invariably present, so fine and numerous as to produce a striated effect without a very clear definition of individual lines. The aspect of the species is sufficiently peculiar to distinguish it readily from other forms.

Stropheodonta lincklaeni was described from the Oriskany sandstone of Albany and Schoharie counties. The species is not common at Becraft mountain.

Leptostrophia magnifica Hall

Plate 7, fig. 36

1859. *Strophodonta magnifica* Hall, *Paleontology of New York.* 3:414, pl. 93, fig. 4; 94, fig. 2a–d; 95, fig. 8

1892. *Leptostrophia magnifica* Clarke, op. cit. p. 413

A few specimens which apparently represent this Oriskany species have been observed, though none of these attain the normal proportions; yet they are large, perplane shells, surpassing the dimensions of Lept. becki and conforming in external and internal features with Lept. magnifica, to which they are provisionally referred.

Leptostrophia oriskania, sp. nov.

Plate 7, fig. 29–35

1892. *Leptostrophia* cf. *becki*, and *L. perplana* Clarke, op. cit. p. 413

The most abundant fossil in these rocks is a species of Leptostrophia of uniformly small size and somewhat variable in the aspect of the exterior. In the work above cited I was disposed to regard some specimens of this, in which the concentric corrugations of the surface are most pronounced, as representing the Helderbergian species Lept. becki, though their uniformly smaller size was recognized; others, having the surface almost or wholly devoid of corrugations, were referred to the middle Devonic species L. perplana Conrad. On a review of the material it has become evident that all have features common to both of those mentioned and represent but a single species. It might be looked on as a small variety of Lept.

becki, were it not for the great variability of the exterior, and perhaps in all respects its structural affiliations are closest with that shell; but it never attains the size of that species, while its persistent small size forms one of its most stable characters.

Shell of medium size, very gently concavo-convex. Hinge-line straight, attaining the greatest width of the shell; at full growth very slightly produced at the cardinal extremities, but in young stages with quite decided extensions. Cardinal area narrow and mainly confined to the pedicle-valve; striated horizontally and crossed vertically by ridges which make themselves apparent on the hinge-line as denticulations. The area is crossed by a narrow delthyrium which is generally covered. Surface of the pedicle-valve covered with fine, rounded striae which increase rapidly by intercalation. At intervals on the surface, usually distant, are sharply defined concentric varices or growth-lines. Accompanying these are concentric corrugations, sometimes so pronounced and regular that the surface suggests that of Leptaena rhomboidalis, but generally finer and irregular. These may extend over the entire surface or be best developed in the umbonal and median parts of the shell; or they may be very obscure and often, when the concentric varices are frequent and strong, may be altogether indistinct. Along the hinge-line the wrinkles are oblique, being parallel to the extended extremities of early growth stages.

On the brachial valve the ornament is of quite the same character. The apophyses and scars of the interior are those prevailing in this genus. The cardinal process is bifurcated, and the posterior face of each division is concave. From the base of this process diverge short, lateral ridges which are highly pustolose, between them lying a shorter median ridge. In both valves the muscular scars are indistinct.

Dimensions. Full grown shells seldom exceed a length of 20 mm and a width of 25 mm.

Brachyprion majus, sp. nov.

Plate 8, fig. 8-13

1892. *Stropheodonta, sp. n.* A. Clarke, op. cit. p. 413

There are two species of this genus, Brachyprion, in this fauna, and both present some similarities to the species of the Helder-

bergian Stropheodonta varistriata (Conrad) Hall. While both complete all the stages of growth represented by that species, they alike pass beyond those and attain adult characters not exemplified in species of earlier date. Brachyprion varistriatum is a common species in the Manlius limestone, and, though usually of small size in the former, sometimes assumes considerable dimensions. Prof. Hall has described as a variety of this species, Stroph. varistriata, var. arata, from "a crystalline band of the shaly limestone of the lower Helderberg group; Becraft's mountain, Hudson", its differential being found in the strong, sharp, subequal striae. The ornament of the species, Brach. varistriatum, specially in its smaller forms, is that of the well known Rafinesquina alternata of the Trenton limestone and many coeval and later shells; that is, it consists of coarser, filiform striae alternating with a group of subequal, finer ones. This character is well expressed on specimens of Brach. majus through early stages and till the maximum of convexity is attained and the pronounced deflection to the anterior margin begins. Thence forward this character becomes modified. In the other species, Brach. schuchertanum, however, early stages do not exhibit this arrangement of the ornament, but start with the surface characters of the var. aratum Hall, retain it for a brief period only, the resultant ornament being distinct from that in any of the allied shells. No stronger argument on behalf of the specific distinction of the var. arata could be adduced.

With regard to the peculiar structure of the hinge which characterizes the genus Brachyprion, both of these Oriskany shells have it well developed; the delthyrium is open and the denticulations of the hinge-line are small and extend only about half way to the cardinal angles.

Shell of quite large size at maturity. Hinge straight and having the full width of the shell; marginal outline elongate lunate. Surface of the pedicle-valve gently convex but strongly sloping in the umbonal region, the greatest elevation and convexity of the valve being attained in front of the center and following a line parallel to the margin.

Thence forward the slope is much more abrupt. The brachial valve conforms in contour with its opposite.

The cardinal area is narrow, the denticulations on the pedicle-valve quite small.

The ornamentation of the valves is, as we have just observed, a series of alternating filiform striae with a group of two to six smaller striae in the intervals. These striae multiply rapidly by bifurcation and intercalation, and the fascicles become increased with considerable irregularity. Immature shells of the species may show only these characters and in this condition represent the normal state of Brach. varistriatum, but at maturity the high convexity and abrupt anterior slope is added, and on this anterior surface the striation is modified by the rapid increase in number of the larger striae and diminution in size and number of the intervening striae. Thus the aspect of the striation becomes much more uniform on these later parts of the shell. It is to be observed, however, that this modification does not always set in at the same period of shell growth, and we may therefore have shells of incomplete growth showing these adult characters outside of the umbonal region and, on the other hand, large shells with adult convexity, retaining the fasciculate striation of early stages. We observe in the species Brach. schuchertanum the presence of an indistinct and irregular median fold and sinus on pedicle and brachial valves, and some trace of a like feature is to be occasionally seen on old shells of this species. The striae are crossed by very fine, elevated, concentric lines which distinctly cancellate the surface.

Brachyprion majus is not an uncommon member of this fauna.

Brachyprion schuchertanum, sp. nov.

Plate 8, fig. 1-7

1892. *Stropheodonta* cf. *radiata* Clarke, op. cit. p. 413

Shells at full size as large or larger than in Brach. majus. Convexo-concave, rising from the umbones regularly to the middle or antemedian portion of the pedicle-valve and sloping thence with uni-

formity. The great convexity and abrupt slope of Brach. majus are absent. Along the middle the brachial valve is depressed by a longitudinal sinus widening anteriorly, seldom well defined at its edges. This is well marked on the interior of the valves and shows itself on the exterior of the pedicle-valve as a broad median ridge passing without definition into the lateral slopes. Hinge-line straight and as long as the width of the shell. Umbo of the pedicle-valve convex and prominent.

The surface of early growth stages is marked by a few coarse, strong, subangular ribs with a few secondary striae. These rapidly increase by division and implantation, so that eventually but little trace of fasciculate arrangement is left, and the surface becomes equally, coarsely and closely striated. These striae are crossed by fine concentric lines, which are sharper than those in Brach. majus, and present a different aspect, on account of the absence of the finer radiating striae which they cancellate in that species. Cardinal and internal characters as in Brach. majus, the row of cardinal denticulations being somewhat larger than in that species.

Early stages of this species are, as observed, suggestive of Brach. aratum Hall, and in some cases recall specimens of Strophеodonta demissa Conrad, from the Hamilton shales.

Leptaena rhomboidalis Wilckens

1892. *Leptaena rhomboidalis* Clarke, op. cit. p. 413

The shells of this species are common and conform to the type of this shell occurring in the Helderbergian and Ulsterian rather than to the large and ventricose form of the Oriskany which has been described by Hall as Strophomena rugosa, var. ventricosa.

Dalmanella perelegans Hall

1859. *Orthis perelegans* Hall, *Paleontology of New York.* 3:171, pl. 13, fig. 4-12

1892. *Orthis perelegans* Clarke, op. cit. p. 413

Shells which can be ascribed to this species have usually undergone some compression which obscures in some degree their specific

characters and at times produces a resemblance to the allied shell, Dalm. subcarinata. Satisfactory evidence of the presence of the latter, is however, still wanting. Both are characteristic brachiopods of the New Scotland beds.

Rhipidomella oblata Hall

Plate 8, fig. 14, 15

1857. *Orthis oblata* Hall, *Paleontology of New York.* 3:162, pl. 10

1892. *Orthis* cf. *oblata* Clarke, op. cit. p. 413

This Helderbergian species is represented by specimens of rather small size and of not very frequent occurrence.

Crania pulchella Hall and Clarke

Plate 8, fig. 16–18

1892. *Crania pulchella* Hall and Clarke, *Paleontology of New York.* v. 8, pt 1, p. 180, pl. 4, fig. 3

1892. *Crania sp. n.*, Clarke, op. cit. p. 413

The specimens of this species from Becraft mountain are frequently of large size and have the radial plications very sharply developed. These are more numerous than in the typical specimens of the species, but, as they rapidly increase with additions to the diameter of the shell, there is no reason for not regarding both forms as of the same specific type.

The original of Cr. pulchella is from the New Scotland limestone, near Clarksville N. Y.

Crania cf. bella Billings

Plate 8, fig. 19, 20

1874. *Crania bella* Billings, *Geol. sur. Canada; Paleozoic fossils.* v. 2, pt 1, p. 15, fig. 5

1892. *Crania sp. n.* Clarke, op. cit. p. 413

This is a generally small shell with smooth surface, upper valve more or less convex, generally concave on the posterior slope, with apex directed slightly backward; sometimes with the posterior margin transverse. It approaches very closely to the species cited, from the

Gaspé limestone no. 5, termed by Billings "Passage beds" from the "Upper Silurian" (Lower Helderberg) to the "Lower Devonian" (fauna mainly of Oriskany species). The shell is less common in the Becraft mountain fauna than C. pulchella.

Pholidops terminalis Hall

Plate 8, fig. 23–25

1859. *Pholidops terminalis* Hall, *Paleontology of New York.* 3:490, pl. 103b, fig. 8a–d

1867. *Pholidops arenaria* Hall. Idem., 4:413, pl. 3, fig. 24

1892. *Pholidops terminalis* Clarke, op. cit. p. 413

Sharply defined impressions of this species are very common.

The original of Ph. terminalis was from the Oriskany sandstone of Cumberland Md., and that of Ph. arenaria from the same formation at Knox N. Y.

Pholidops sp.?

Plate 8, fig. 21, 22

1892. *Pholidops sp. n.*, Clarke, op. cit. p. 413

A few specimens have been seen of a very small Pholidops, unlike Ph. terminalis and the group of species to which it belongs, with terminal beaks, but representing the more common expression of the genus with subcentral beaks, represented by species which range through the Paleozoic rocks from the lower Siluric into the Carbonic.

Lingula cf. rectilatera Hall

1859. *Lingula rectilatera* Hall, *Paleontology of New York.* 3:156, pl. 9, fig. 6, 8

1892. *Lingula sp.*, Clarke, op. cit. p. 413

A single incomplete example retains the parallel sides and transverse anterior margin of this species described from the New Scotland limestone.

BRYOZOA

Rhombipora rhombifera Hall

See *Paleontology of New York.* 6:18, pl. 11, fig. 15, 17–20; pl. 23, fig. 11, 12

A few twigs of a Rhombipora which agree in size and structure with this Helderbergian species have been observed.

Stictopora sp?

A few specimens of this genus have been observed, but none have the exterior well enough preserved to justify an attempt at their identification, though in general aspect as well as in the character of the cells so far as ascertainable the species is very closely allied to St. granulata Hall of the Helderbergian.

Unitrypa lata Hall

1887. *Fenestella* (*Unitrypa*) *lata* Hall, *Paleontology of New York.* 6:136, pl. 53, fig. 1–10

This species was described from the Onondaga limestone of Walpole Ont. It is not uncommon in the Oriskany of Becraft mountain.

Unitrypa acclivis Hall

1887. *Fenestella* (*Unitrypa*) *acclivis* Hall, *Paleontology of New York.* 6:138, pl. 52, fig. 16–23.

Not common. The originals were from the Onondaga limestone of Walpole Ont.

Lichenalia cf. crassa Hall

For figures of *L. crassa*, see *Paleontology of New York.* v. 6, pl. 11, fig. 21, 22

Specimens which seem to agree with this Helderbergian species are occasionally found.

Polypora separata Hall (?)

See *Paleontology of New York.* 6:166, pl. 39, fig. 10, 11

Specimens very similar to this species but having larger fenestrules are common. Polypora separata was described from the Onondaga limestone of Walpole Ont.

Polypora, sp. indes.

Polyporella cf. compressa Hall

Of the Helderbergian.

Isotrypa, sp. indes.

Reteporina, sp. indes.

Fenestella biseriata Hall (?)

See *Paleontology of New York.* 6:113, pl. 42, fig. 16–18

Fronds having the characters of this species are occasionally found The originals of the species were from the Onondaga limestone at Cherry Valley N. Y.

Hemitrypa columellata Hall

1887. *Fenestella* (*Hemitrypa*) *columellata* Hall. *Paleontology of New York.* 6:146

This species, described from the Onondaga limestone of Walpole Ont., is occasionally found in the Becraft mountain Oriskany.

Hederella magna Hall and Simpson

Plate 9, fig. 10

1887. *Hederella magna* Hall and Simpson, *Paleontology of New York.* 6:280, pl. 65, fig. 15

To this species is referred a Hederella characterized by its short, stout, strongly rugose and somewhat irregular cells, erect at their extremities, growing in a double series which proceed from a central stock generally in part concealed by overgrowth. The cells are larger than in any of the other species here found.

The original of this species was from the Hamilton shales of York N. Y.

Hederella arachnoidea, sp. nov.

Plate 9, fig. 11

This is the smallest of the species here observed, the zoarium being very fine, creeping in an irregular manner over the surface of attachment, generally showing the biserial stock, but this is often obscured by frequent and irregular branching. The cells are narrow, often flattened, branching taking place at quite distant intervals but alternately on opposite sides. The species may be distinguished from Hed. gracilior by its finer, more elongate cells, its more distant branching and much more diffuse and irregular zoarium.

Hederella ramea, sp. nov.

Plate 9, fig. 9

A very graceful zoarium consisting of a primitive stock from which branches arise on either side at distant and highly irregular intervals, the secondary branching arising from the principal branches in such a way as to produce a palmate frond. The cells are subcylindric, smooth and procumbent at their extremities.

Hederella gracilior, sp. nov.

Plate 9, fig. 10

In this species the zoarium attains about the size of that in Hed. filiformis Hall and Simpson of the Hamilton shales, but the form of the colony is less diffuse, the double series of cells retaining a compact form and the entire zoarium being a miniature of Hed. magna. To the difference in size of the cells in these two species are added as distinguishing characters the flattened and less rugose condition of the cells and their more slender and regular form.

CRINOIDEA

Edriocrinus becraftensis, sp. nov.

Plate 9, fig. 12, 13

The calyxes of this species may be distinguished from those of Edr. sacculus Hall from the Oriskany sandstone of Cumberland Md. in their elongate, much more slender and very gradually enlarging form, and generally quite small size. They are blunt but not broad at the base and enlarge upward with gently incurving sides. In one instance only has the upper edge of the calyx been observed, and except for this edge no specimen shows traces of the component plates.

The casts of the calyx are not infrequent.

ANTHOZOA

Zaphrentis sp.

These fossils occur as casts of the calyx. Two forms are evident, one, the smaller, conforming to the characters of Zaphrentis, the larger differing from this structure in the presence of double series of tubercles in the lamellar interspaces.

(?) Ptychonema helderbergiae Hall

See *Paleontology of New York.* 6:15, pl. 9, fig. 16, 17

Several specimens have been found which have a ramose stock and attain the proportions of this species both in size of stock and cell apertures.

Vermipora streptocoelia, sp. nov.

Plate 9, fig. 7, 8

Ramose twigs of from 8 to 12 mm diameter are bundles of tubes like those of Vermipora, but, instead of having a direct course outward from their point of growth, as in the known species of the genus, these tubes are exceedingly irregular, wandering about in serpentine courses as they approach the termination, but appearing to be straighter within the substance of the stock. The material illustrating this peculiar form is not very favorably preserved, and the species will be an interesting subject for farther study.

Vermipora serpuloides Hall, var.

See *Paleontology of New York.* 6:5, pl. 2, fig. 24–31

Vermipora serpuloides of the Helderbergian differs from this species in the smaller size and greater number of its tubules. The colony is slender and branching. With better material it is probable that this form would prove a distinct species.

Cladopora smicra, sp. nov.

Plate 9, fig. 3–6

Small and sparsely branching colonies with stems from 3 to 5 mm in diameter, bearing small, very oblique cells in 6 to 8 vertical rows. The apertures of these cells are much compressed, the upper surface being broadly arched and the under surface being more or less excavated in the substance of the stock. On the older parts of the stem the cells are reduced in form to scales covering circular pits. The species is distinguished from Clad. styphelia by its slender form and much less conspicuous cells. The species exists also in the Onondaga limestone of western New York.

Cladopora styphelia, sp. nov.

Plate 9, fig. 1, 2

There are found occasionally twigs of Cladopora of considerable size, bearing very large oblique cells which are arranged more or less irregularly in 8 to 10 vertical, alternating rows. These stems have a diameter of 6 to 8 mm and the apertural diameter of the cells is from 2 to 4 mm. The species is readily recognized by the size of the cells and their angular projection at their apertures, which gives the colony a very rough exterior.

Aulopora cf. schoharie Hall

See *Paleontology of New York.* 6:3, pl. 2. fig. 1–6

The few specimens of Aulopora observed are very closely allied to this Helderbergian species, but appear to be persistently of larger size.

Monotrypella arbusculus Hall and Simpson

1887. *Chaetetes* (*Monotrypella*) *arbusculus* Hall and Simpson, *Paleontology of New York.* 6:12, pl. 9, fig. 1–8

Of this Helderbergian species a few very characteristic examples have been observed.

HYDROZOA

Dictyonema cf. splendens Billings

1874. *Dictyonema splendens* Billings, *Geol. sur. Canada; Paleozoic fossils.* v. 2, pt 1, p. 12, fig. 2, 2a

Mr Billings described his species from the lowest of the Gaspé series of limestones (no. 1) which, according to his determinations, contains a fauna with notable Helderbergian affiliations. This species does not agree closely with the species known from the New Scotland limestone (D. crassum Girty), but is comparable to a form observed only in some fragments from the calcareous Oriskany.

VERTICAL RANGE OF THE SPECIES OF THE ORISKANY FAUNA AT BECRAFT MOUNTAIN

	1 Helderbergian (Coeymans, New Scotland, Becraft and Kingston limestones)	2 Oriskany Calcareous facies	3 Oriskany Arenaceous beds	4 Upper Helderberg (Ulsterian)	5 Hamilton (Erian)
1 Dalmanites (Synphoria) stemmatus *C.*		x			
2 D. (S.) stemmatus *var.* convergens *C.*		x			
3 D. phacoptyx *H. & C.*		x		x	
4 D. bisignatus *C.*		x			
5 Phacops correlator *C.*		x			
6 P. logani *H.*	x	x			
7 Cordania becraftensis *C.*		x			
8 C. hudsonica *C.*		x			
9 Cyphaspis minuscula *H.*		x		x	
10 Proetus conradi *H*		x		x	
11 Acidaspis tuberculata *Conrad*	x	x			
12 Lichas *cf.* pustulosus *H.*	x	x			
13 Homalonotus *sp.*?		x			
14 Beyrichia *sp.*?		x			
15 Plumulites		x			
16 Annelid teeth		x			
17 Autodetus beecheri *C.*		x			
18 Spirorbis assimilis *C.*		x			
19 Cornulites cingulatus *H.*	x	x			
20 Tentaculites elongatus *H*	x	x			
21 T. (?) acus *C.*		x			
22 Conularia *sp.*		x			
23 Bellerophon *sp.*		x			
24 Cyrtolites expansus *H.*		x	x		
25 Pleurotomaria *sp.*		x			
26 Diaphorostoma desmatum *C.*		x			
27 D. ventricosum *Conrad*		x	x		
28 Strophostylus expansus *Conrad*		x	x		
29 Orthonychia tortuosa *H.*		x	x		
30 Platyceras *cf.* gebhardi *H.*		x	x		
31 P. nodosum *Conrad*		x	x		
32 Pterinea *sp.*?		x			
33 Pterinopecten subequilatera *H.*	x	x			
34 P. proteus *C.*		x			
35 P. signatus *C.*		x			
36 P. pumilus *C.*		x			
37 Aviculopecten *sp.*		x			
38 Lyriopecten *sp.*		x			
39 Actinopteria communis *H.*	x	x			
40 A. insignis *C.*		x			

	1 Helderbergian (Coeymans, New Scotland, Becraft and Kingston limestones)	2 Oriskany Calcareous facies	3 Oriskany Arenaceous beds	4 Upper Helderberg (Ulsterian)	5 Hamilton (Erian)
41 Goniophora *sp*		x			
42 Megambonia crenistriata *C*		x			
43 Cypricardinia lamellosa *Conrad*		x		x	
44 Conocardium inceptum *H.* (?)	x	x			
45 Oriskania sinuata *C*		x			
46 Cryptonella (?) fausta *C*		x			
47 C. *sp. nov*		x			
48 Rensselaeria ovoides *Eaton*		x	x		
49 Megalanteris ovalis *H*		x	x		
50 Eatonia medialis *Van*	x	x			
51 E. peculiaris *Conrad*	x	x	x		
52 Camarotoechia barrandii *H*		x	x		
53 C. fitchana *H.* (?)		x	x		
54 C. oblata *H*		x	x		
55 C. dryope *Billings*		x			
56 C. *sp* ?		x			
57 Anastrophia *sp*		x			
58 Coelospira concava *H*	x	x			
59 C. dichotoma *H*		x	x		
60 Leptocoelia flabellites *Conrad*		x	x		
61 Trematospira multistriata *H*	x	x			
62 Meristella lentiformis *C*		x			
63 M. lata *H*		x	x		
64 M. (?) vascularia *C*		x			
65 Spirifer arenosus *Conrad*		x	x		
66 S. murchisoni *Castelnau*		x	x		
67 S. saffordi *H*	x	x			
68 Metaplasia pyxidata *H*		x	x	x	
69 Cyrtina varia *C*		x			
70 Chonetes hudsonica *C*		x			
71 Chonostrophia complanata *H*		x	x		
72 Anoplia nucleata *H*		x	x		
73 Orthothetes becraftensis *C*		x			
74 Hipparionyx proximus *Vanux*		x	x		
75 Stropheodonta lincklaeni *H*		x	x		
76 Leptostrophia magnifica *H*		x	x		
77 L. oriskania *C*		x			
78 Brachyprion schuchertanum *C*		x			
79 B. majus *C*		x			
80 Leptaena rhomboidalis *Wilck*	x	x			
81 Dalmanella perelegans *H*	x	x			
82 Rhipidomella oblata *H*	x	x			

	1 Helderbergian (Coeymans, New Scotland, Becraft, and Kingston limestones)	2 Oriskany Calcareous facies	3 Oriskany Arenaceous beds	4 Upper Helderberg (Ulsterian)	5 Hamilton (Erian)
83 Crania pulchella *H. & C.*	x	x			
84 C. cf. bella *Billings*		x			
85 Pholidops terminalis *H*		x	x		
86 P. *sp*		x			
87 Lingula *cf.* rectilatera *H.*	x	x			
88 Rhombipora rhombifera *H.*	x	x			
89 Stictopora *sp.*		x			
90 Unitrypa lata *H*		x		x	
91 U. acclivis *H.*		x		x	
92 Lichenalia *cf.* crassa *H.*	x	x			
93 Polypora separata *H.* (?)		x		x	
94 P. *sp.*		x			
95 Polyporella *cf.* compressa *H.*	x	x			
96 Fenestella biseriata *H.* (?)		x		x	
97 Hemitrypa columellata *H.*		x		x	
98 Isotrypa *sp.*		x			
99 Reteporina *sp.*		x			
100 Edriocrinus becraftensis *C.*		x			
101 Zaphrentis		x			
102 Ptychonema helderbergiae *H.* (?)	x	x			
103 Vermipora streptocoelia *C.*		x			
104 V. serpuloides *H. var*	x	x			
105 Cladopora smicra *C.*		x			
106 C. styphelia *C.*		x			
107 Aulopora *cf.* schoharie *H.*	x	x			
108 Monotrypella arbusculus *H. & S.*	x	x			
109 Hederella magna *H. & S.*		x			x
110 H. arachnoidea *C.*		x			
111 H. ramea *C.*		x			
112 H. graciliora *C*		x			
113 Dictyonema *cf.* splendens *Billings*		x			
Total	25	113	24	10	1

With our present knowledge there are thus 113 recognizable, distinct specific forms in the fauna of the Oriskany at Becraft mountain, and of these 94 are identifiable with species already known or are clearly new forms peculiar to the fauna. Of the 94, 25 preceded the

introduction of Oriskany sedimentation, having been first described from the fauna of the Helderbergian. In the arenaceous beds of the Oriskany 23 occur; 10 range upward into the faunas of the Upper Helderberg (Ulsterian), but a part of these are restricted to the sandy, lower beds of this formation (Schoharie grit), and others have been noted only in the chert beds of Ontario, Canada, where the intermixture of Oriskany and Onondaga species is well marked and has been recorded by Schuchert. The fauna contains 35 species which so far as known are peculiar to it. On farther analysis of the foregoing table, it is evident in some cases that species which range down and upward are restricted to particular groups. Thus the alien trilobites are from the Helderbergian; the gastropods are exclusively Oriskany; while the alien lamellibranchs are mostly Helderbergian. But the leading factor of the fauna, the brachiopod, has its derivation as freely from below as in the Oriskany invasion.

FAUNAL VALUES OF THE SPECIES

The following is a statement of the faunal values of these species or their closest affiliations with species of other faunas.

Dalmanites (Synphoria) stemmatus *C.*—D. (Syn.) Maecurua *C.*, Maecurú sandstone, Amazonas
" var. convergens *C.*
D. phacoptyx *H. & C.*—idem, Onondaga limestone, Ontario
D. bisignatus *C.*—D. dentatus *Barrett*, Helderbergian, Port Jervis
D. pleuroptyx *Conrad*, Helderbergian and Ulsterian, N. Y.
Phacops correlator *C.*—Ph. anceps *C.*, Onondaga limestone, Ontario
Ph. braziliensis *C.*, Maecurú sandstone, Amazonas
Ph. logani H.—idem, Helderbergian, N. Y.
Cordania becraftensis *C.*—Cord. cyclurus *H. & C.*, Helderbergian, N. Y.
Cord. hudsonica *C.*
Cyphaspis minuscula *H.*—idem, Ulsterian, N. Y.
Proetus conradi *H.*—idem, Schoharie grit, N. Y.
Acidaspis tuberculata *Conrad*—idem, Helderbergian, N. Y.
Lichas *cf.* pustulosus *H.*—idem, Helderbergian, N. Y.
Homalonotus *sp.*
Autodetus beecheri *C.*

Spirorbis assimilis *C.*
Cornulites cingulatus *H.*—idem, Helderbergian, N. Y.
Tentaculites elongatus *H.*—idem, Helderbergian, N. Y.
T. (?) acus *C.*
Bellerophon *sp.*
Cyrtolites expansus *H.*—idem, arenaceous Oriskany, N. Y. and Pa.
Pleurotomaria sp.
Diaphorostoma desmatum C.—D. ventricosum *Conrad*, arenaceous Oriskany, N. Y.
D. ventricosum *Conrad*—idem, arenaceous Oriskany, N. Y.
Strophostylus expansus *Conrad*—idem, Oriskany, Md.
Orthonychia tortuosa *H.*—idem, arenaceous Oriskany, N. Y.
Platyceras *cf.* gebhardi *H.*—idem, Oriskany, Md.
P. nodosum *Conrad*—idem, arenaceous Oriskany, N. Y.
Pterinea ?—Megambonia lamellosa *H.*, arenaceous Oriskany, N. Y.
Pterinopecten subequilatera *H.*—idem, Helderbergian, N. Y.
Pterinopecten proteus *C.*
Pt. signatus *C.*—Pt. terminalis *H.*, Ulsterian, N. Y.
Pt. bellulus *H.*, Helderbergian, N. Y.
Pt. pumilus C.—Vertumnia, Mesodevonic
Aviculopecten *sp.*
Lyriopecten *sp.*
Actinopteria communis *H.*—idem and A. textilis *H.*, Helderbergian, N. Y.
A. insignis *C.*—A. communis *H.*, Helderbergian, N. Y.
Goniophora *sp.*
Megambonia crenistriata *C.*—M. bellistriata *H.*, Helderbergian, N. Y.
M. cardiiformis *H.*, Onondaga limestone, N. Y.
Cypricardinia indenta *Conrad*—idem, Onondaga limestone and Hamilton, N. Y.
C. lamellosa *H.*, Helderbergian, N. Y.
Conocardium inceptum *H.*—idem, Helderbergian, N. Y.
Oriskania sinuata *C.*—O. navicella *H. & C.*, Oriskany, N. Y.
Cryptonella fausta *C.*—idem (?), Helderbergian, N. Y.
Rensselaeria ovoides *Eaton*—idem, arenaceous Oriskany, N. Y. and Md.
Megalanteris ovalis *H.*—idem, arenaceous Oriskany, N. Y.
Eatonia medialis *Van.*—idem, Helderbergian, N. Y.
E. peculiaris *Conrad*—idem, Helderbergian and arenaceous Oriskany, N. Y.
Camarotoechia barrandii *H.*—idem, arenaceous Oriskany, N. Y.
C. fitchana *H.* (?)—idem, arenaceous Oriskany, N. Y.
C. oblata *H.*—idem, arenaceous Oriskany, N. Y.

C. dryope Bill.—idem, Gaspé limestone no. 8
C. *sp.*
Anastrophia *sp.*
Coelospira concava *H.*—idem, Helderbergian, N. Y.
C. dichotoma *H.*—idem, arenaceous Oriskany
Leptocoelia flabellites *Conrad*—idem, arenaceous Oriskany, N. Y., Gaspé (limestone no. 8 and sandstone), Brazil, Falkland islands, S. Africa
Trematospira multistriata *H.*—idem, Helderbergian, N. Y.
Meristella lentiformis *C.*—M. lenta H., Oriskany, Ontario
M. lata *H.*—idem, arenaceous Oriskany, N. Y.
M (?) vascularia *C.*
Spirifer arenosus *Conrad*—idem, arenaceous Oriskany, N. Y. and Md.
S. murchisoni *Castelnau*—idem, arenaceous Oriskany, N. Y.
S. saffordi H.—idem, Helderbergian, N. Y. and Tenn.
Metaplasia pyxidata *H.*—idem, arenaceous Oriskany, N. Y.; Onondaga limestone, Ontario
Cyrtina varia *C.*—C. rostrata, arenaceous Oriskany, N. Y.
C. dalmani, Helderbergian, N. Y.
Chonetes hudsonica *C.*—idem Helderbergian, N. Y. (?), Gaspé sandstone
Chonostrophia complanata *H.*—idem, arenaceous Oriskany, N. Y.
Ch. helderbergia *H. & C.*, Helderbergian, N. Y.
Anoplia nucleata *H.*—idem, arenaceous Oriskany, N. Y., Edmund's hill, Aroostook co. Me.
Orthothetes becraftensis *C.*——sp. indes. Gaspé sandstone
Hipparionyx proximus *Van.*—idem, arenaceous Oriskany, N. Y., Gaspé limestone no. 8
Stropheodonta lincklaeni *H.*—idem, Oriskany, N. Y.
Leptostrophia oriskania—L. becki *H.*, Helderbergian, N. Y.
L. perplana *Conrad*, Upper Helderberg and Hamilton, N. Y.
L. magnifica *H.*—idem, arenaceous Oriskany, N. Y.
Brachyprion schuchertanum *C.*—B. aratum *H.*, Helderbergian, N. Y.
Stropheodonta demissa *Conrad*, Hamilton
B. majus C.—B. varistriatum *Conrad*, Helderbergian, N. Y.
Leptaena rhomboidalis Wilck.—idem, Helderbergian and Ulsterian, N. Y.
Dalmanella perelegans *H.*—idem, Helderbergian, N. Y.
D. subcarinata *H.*—Helderbergian, N. Y.

Rhipidomella oblata *H.*—idem, Helderbergian, N. Y.
Crania pulchella *H. & C.*—idem, Helderbergian, N. Y.
C. *cf.* bella *Bill.*—idem, Gaspé limestone no. 5.
Pholidops terminalis *H.*—idem, ? Oriskany, Md. N. Y.
Ph. *sp?*
Lingula *cf.* rectilatera *H.*—idem, Helderbergian, N. Y.
Rhombipora rhombifera *H.*—idem, Helderbergian, N. Y.
Stictopora *sp.*
Unitrypa lata *H.*—idem, Onondaga limestone, Ontario
U. acclivis *H.*—idem, Onondaga limestone, Ontario
Lichenalia *cf.* crassa *H.*—idem, Helderbergian, N. Y.
Polypora separata *H.* (?)—idem, Onondaga limestone, Ontario
Polypora
Polypora *cf.* compressa *H.*—idem, Helderbergian, N. Y.
Fenestella biseriata *H.* (?)—idem, Onondaga limestone, Ontario
Hemitrypa columellata *H.*—idem, Onondaga limestone, Ontario
Isotrypa
Reteporina
Edriocrinus becraftensis *C.*—E. sacculus *H.*, Oriskany, Md
Ptychonema helderbergiae *H.* (?).—idem, Helderbergian, N. Y.
Vermipora streptocoelia *C.*
Vermipora serpuloides *H.* var.—idem, Helderbergian, N. Y.
Cladopora smicra *C.*—idem, Onondaga limestone, N. Y.
C. styphelia *C.*
Aulopora *cf.* schoharie *H.*—idem, Helderbergian, N. Y.
Monotrypella arbusculus *H. & S.*—idem, Helderbergian, N. Y.
Hederella magna *H.*—idem, Hamilton shales, N. Y.
H. arachnoides *C.*
H. ramea *C.*
H. gracilior *C.*

We may briefly summarize this tabulation as follows. Of the 94 clearly defined species of this fauna, 38 represent expressions of species which began their existence in Helderbergian times; on the other hand, but 18 of the species of the fauna continued their existence or appear to be represented by closely allied forms beyond the close of the Oriskany sedimentation. 29 are represented in the earlier known fauna of the arenaceous beds of the Oriskany.

Chapter 3

NATURE AND DISTRIBUTION OF THE ORISKANY FAUNA IN NEW YORK

The fauna of the calcareous Oriskany is in no sense a mixed assemblage, or an intermingling of faunas of adjacent provinces. The sequence of life has continued without apparent interruption from the Helderbergian (Kingston beds) into the sediments of the Oriskany and the Onondaga limestone.

It is extremely probable that important variations from the fauna of the Catskill shaly (New Scotland) limestone had already made their appearance in the Becraft limestone, and that we first become acquainted with some of these in the study of the calcareous Oriskany. No proof therefore could be adduced more emphatically confirmatory of the intimate faunal relations of the Helderbergian with the Oriskany fauna and its successors than the facts brought forward in this paper.

The fauna discussed in the foregoing pages is that of the *calcareous facies of the Oriskany formation.* The sedimentary deposits of this and neighboring sections were essentially limestones notwithstanding the silicious content, whether diffused through the mass or segregated as cherty secondary product. In the earlier presentation of this fauna it was regarded as of lower Oriskany horizon, on account of the presence of many Helderbergian species, but we believe it will be more correctly construed as the representative of the proper and normal Oriskany fauna, the true fauna of this time unit inclosed in the sediments of its proper habitat.

DISTRIBUTION OF THE CALCAREOUS FACIES OF THE ORISKANY IN NEW YORK

Ulster county. A complete section of the strata from the Coeymans limestone through to the summit or almost to the summit of the Oriskany

formation is exposed near Kingston, along the West Shore railroad one half mile southeast of Rondout creek.[1]

On the Becraft limestone, which is 60 feet thick, lies a very considerable thickness (222 feet) of impure schistose limestones, the "upper shaly" limestone of W. M. Davis, and the *Kingston beds* of this paper. In the reported section these beds have been subdivided with every variation in the sediment, which is in places a compact blue limestone carrying silicious matter, in others a gray, shaly and argillaceous limestone. The fossils of all its layers are those of the true New Scotland limestone faunas, the contents of the higher layers varying little from those of the lower.

I have identified the following species. (In making this section Mr Van Ingen and Dr Ruedemann divided these beds into 18 subdivisions, numbered from lowest to highest, 4–21. These minor divisions were based solely on slight changes in the character of the sediment. In the list of fossils I quote these subdivisions by number in order to show the range of the species.)

Dalmanites pleuroptyx, 4, 12, 21
Phacops logani, 12, 15, 16, 19, 21
Homalonotus vanuxemi, 8, 9, 12, 19
Acidaspis tuberculata, 12, 16
Tentaculites elongatus, 16, 19, 21
Cypricardinia lamellosa, 16
Camarotoechia *cf.* campbellana, 4
C. mutabilis, 8
Eatonia peculiaris, 4, 6, 14
E. medialis, 9, 19
Spirifer cyclopterus, 4, 5, 12
S. perlamellosus, 4, 5
S. modestus, 12, 16
Coelospira concava, 4, 20, 21
Atrypa reticularis, 4
Meristella *cf.* laevis, 4, 5
Leptaena rhomboidalis, 4, 6
Stropheodonta becki, 4, 20, 21
Strophonella punctulifera, 4
Rhipidomella oblata, 4, 5, 6, 21
Dalmanella subcarinata, 5, 9
D. planoconvexa, 12, 14, 15
Pholidops ovata, 16, 19, 20, 21
Zaphrentis roemeri, 5
Duncanella rudis, 9, 12, 14, 16, 20
Pleurodictyum lenticulare, 9, 21
Hindia fibrosa, 6

[1]For the detailed succession here I have largely relied on observations made at my request by Mr Gilbert Van Ingen, who, aided by Dr Rudolf Ruedemann, has carefully collected from all the strata.

Immediately above these beds appear 11 feet, 3 inches of chert beds, followed by 18 feet, 7 inches of a fine quartz pebble conglomerate (=29 feet, 10 inches). Then comes in a silicious and quite fossiliferous limestone 5 feet, 6 inches in thickness (no. 29 of the section) and over it about 36 feet of chert bands containing a few fossils. The entire thickness of the deposits from the top of the Kingston beds to the base of the Esopus shale is about 60 feet.

The fauna of this part of the section is essentially contained in the calcareous layer, and is the following:

Dalmanites *cf.* stemmatus
Phacops logani
Proetus conradi
Tentaculites elongatus
Diaphorostoma ventricosum
D. desmatum
Cyrtolites *sp.*?
Platyceras tortuosum
Cryptonella fausta
Megalanteris ovalis
Camarotoechia pliopleura
Camarotoechia barrandii
Eatonia peculiaris
Meristella lentiformis
Spirifer murchisoni
Leptocoelia flabellites
Chonetes hudsonica
Chonostrophia complanata
Leptostrophia oriskania
Edriocrinus sacculus
Cladopora smicra

All of these species with the exception of Edriocrinus sacculus are observed in the Becraft mountain Oriskany fauna. No species occur in the chert bands which are not represented here.

At Glenerie, 7 miles north of Kingston, the same calcareous beds of the Oriskany are finely fossiliferous, probably affording a more complete representation of this fauna. The following are among the species identified:

Dalmanites *cf.* stemmatus
Phacops logani
Tentaculites elongatus
Diaphorostoma ventricosum
D. desmatum
Cyrtolites *sp. n.*
Platyceras gebhardi
P. reflexum
Meristella lentiformis
Spirifer arenosus
S. murchisoni
Trematospira *sp. n.*
Anoplia nucleata
Leptaena rhomboidalis, *var.* ventricosa
Leptostrophia magnifica
L. oriskania

Oriskania sinuata
Megalanteris ovalis
Camarotoechia oblata
C. pliopleura
Leptocoelia flabellites
Coelospira dichotoma
Meristella lata
Orthothetes becraftensis
O. large *sp. n.*
Brachyprion schuchertanum
Hipparionyx proximus
Chonetes hudsonica
Edriocrinus sacculus

This association has some peculiarities, e.g. the presence of some of the Cumberland Md., species which have not before been observed in the Oriskany of New York (Platyceras gebhardi and P. reflexum) and several forms of novel aspect.

Orange county. In the southern extension of these beds a similar fauna accompanies the calcareous strata. In Orange county true silicious sandstones are absent but the pebble beds and cherts are well defined. These features have been clearly brought out by the work of Dr Heinrich Ries in his special report on the geology of this county, published in the *15th annual report of the New York state geologist*, 1898, p. 402, 433, etc. He says:

The two belts of Oriskany which occur in this county present widely different characters. The western belt forms the western part of the Helderberg ridge, which extends up the Neversink valley from Port Jervis. It consists of fine-grained, shaly sandstones and impure limestones, the latter often containing many fossils. The limestones weather to a soft, red rock, from which the fossils may often be dug with a knife. The beds dip to the westward under the Esopus slates and Pleistocene deposits of the Neversink valley, but the bedding is almost everywhere obscured and there is present a pronounced cleavage which causes the rock to split into very thin layers. The cleavage generally dips steeply to the east. There are also present cherty bands containing fossils. The Oriskany forms narrow ridges and the thickness of the formation is about 125 feet [in the vicinity of Port Jervis].

The second Oriskany area is along the western side of Bellvale and Skunnemunk mountains, where it affords a fine-grained red or gray quartzite which changes locally into a conglomerate.

Fossils occur very sparingly in the silicious beds of the western area, Ries recording there Anoplia nucleata, Leptocoelia flabellites and Leptaena rhomboidalis. But on the west

ern line of arenaceous limestones from Cuddebackville to Port Jervis the species are those characteristic of these calcareous beds in the localities already considered, to wit (Ries):

Platyostoma depressum	Meristella lata
Tentaculites elongatus	Leptocoelia flabellites
Orbiculoidea grandis	Coelospira dichotoma
Chonostrophia complanata	Eatonia peculiaris
Spirifer murchisoni	Edriocrinus sacculus

The difference in the lithologic character of these beds on the eastern and the western flanks of the eroded Appalachian ridge is striking and may be construed as evincing the nearer approach of the easterly silicious and pebbly beds to the ancient shore line.

At Port Jervis the sections exposed at the Nearpass, Buckley and Bennett quarries have been given by Dr S. T. Barrett.[1] Here are 150 feet of the upper shaly (Kingston) beds lying above the Becraft limestone, and these are followed by the calcareous strata (5–10 feet) termed by Mather and Horton the Trilobite beds, which are specially characterized by the presence of Dalmanites dentatus Barrett.

Dr Barrett gives the following species as occurring in this stratum:

Homalonotus vanuxemi	Strophonella cavumbona
Dalmanites pleuroptyx	S. leavenworthana
D. nasutus	Stropheodonta becki
D. dentatus	Brachyprion varistriatum
[D. dolphi]	Chonostrophia complanata
Hyolithes centennialis	Rensselaeria mutabilis
Tentaculites elongatus	Orthis subcarinata
Holopea antiqua	O. multistriata
Loxonema fitchana	Spirifer murchisoni
Pterinea textilis	Cyrtina rostrata
Leptaena rhomboidalis	Orbiculoidea discus
Strophonella conradi	O. conradi
Stropheodonta planulata	Schizocrania (?) superincreta

[1] Amer. jour. sci. 1877. 13:386.

I have not had opportunity to verify all of these identifications, but the list as it stands shows a predominance of Helderbergian species. In fact, its Oriskany representation seems to me largely dependent on the identity of the specimens here regarded as Spirifer arrectus (=S. murchisoni). I am satisfied that the Chonostrophia is the form (C. helderbergiae) of the New Scotland beds, and at all events the character of the rock shows the fossils to be an agglomerated mass of remains brought together by wave wash. Present evidence indicates that this is not an Oriskany nor indeed a transition fauna but a proper part of the Kingston limestone beds.

Albany and Schoharie counties. To the north and west of the Kingston sections, through the Helderberg mountains the Oriskany formation becomes thinner and gradually loses its calcareous character. On the Oniskethau creek near Clarksville it is represented by a foot or two of dark compact chert. It is a gray, quartzitic sandstone about two feet thick at Countryman hill, near New Salem. At the top of the hill south of the Indian Ladder it has much the same character and thickness and abounds in Spirifer arenosus, Sp. murchisoni, Meristella lata, etc. South of High point, near Altamont, the rock becomes slightly calcareous.

At Knox it is finely exposed as a compact quartz sandstone though not more than 2 to 3 feet thick.

On West mountain, Schoharie, at the house of George Acker (Murphy farm), above the Becraft limestone rest about 10 feet of a gray, schistose, arenaceous limestone, which terminates above in a hard quartzite. The calcareous content of the rock is considerably less than the silicious. Fossils are abundant:

Rensselaeria ovoides
Stropheodonta magniventra
Spirifer arenosus
Spirifer murchisoni
Pholidops terminalis
Meristella lata, etc.

In none of these sections can the Oriskany strata be properly termed sandstone, in the sense in which that term was originally applied to it in 1837.

THE ORIGINAL ORISKANY SANDSTONE

The name *Oriskany sandstone* was applied by Vanuxem to white or yellowish, often friable and crumbling quartz sandstone exposed at Oriskany Falls, Oneida co., where it has a thickness of 20 feet. All calcareous beds are here wanting and the transition from the underlying Manlius limestone is abrupt, but fossils are found in abundance though not in great variety, the species being for the most part, Spirifer arenosus, S. murchisoni, Rensselaeria ovoides, Hipparionyx proximus, Chonostrophia complanata and Meristella lata. This quality of rock does not occur in any of the eastward exposures of the Oriskany from Albany county to the New Jersey line except as an occasional thin streak without fossils. From Oriskany Falls westward no calcareous beds appear except toward the top of the deposit as the sedimentation grades into that of the Onondaga limestone above. Through Onondaga county into Cayuga, the white, often granular, sandstone is frequently exposed, perhaps nowhere better than at its extreme western appearance at Yawger's woods just north of Union Springs. Vanuxem observed that at no other outcrop of this sandstone are the fossils so finely preserved.

The character of the Oriskany deposit in New York from Schoharie county westward may be regarded in a general way as a series of arenaceous lenses (in strike section) connected by thin sheets of quartzitic sandstone. The outcrops at Oriskany Falls and Yawger's woods are such lenticular masses. Others occur in the sections at Jamesville and Skaneateles Falls and the last that is well marked in the westernmost extension of the formation occurs at Phelps, Ontario co. Between that point and Buffalo the rock may be traced as an undulated sheet a few inches thick composed of angular pieces of the underlying waterlime cemented by dark quartz sand.

At the horizon of the formation in the deep salt shaft put down at Livonia, Livingston co., was a 4½ foot layer at a depth of 1000 feet. This layer was a hard, compact quartz sand, almost a quartzite, which in its lower part contained fragments of the hydraulic limestone on which it rests, cemented

together in the mass. The few traces of fossils in this rock indicated for the most part Ulsterian species, Pentagonia unisulcata, Pentamerella allied to P. arata, but also a Spirifer, probably S. arenosus. In the Buffalo cement co.'s quarries at Buffalo, the Oriskany sandstone is found to lie in small masses which have been washed into the cavities of the corroded surface of the Manlius waterlimes and in vertical fissures filled with white quartz sand which traverse the Manlius limestone and the Eurypterus-bearing cement beds beneath. Fuller reference to this occurrence is made on a subsequent page.

This variation in thickness in different meridional sections results in what appears at present an actual absence of the formation from the rock series in certain places. It has thus not been detected in the region about Cedarville, Herkimer co. Again it makes an abrupt appearance at Splitrock near Syracuse. In Seneca county it does not manifest itself at all, but turns up in Ontario county at the village of Phelps, as just noted. Other evidences of this interrupted deposition occur between Ontario county and Lake Erie.

Such discontinuity of the sand deposits of the Oriskany are indications of an exposed and broken coast line, in the western part of the state, the sand feebly encroaching on areas of entirely different deposition.

The great brachiopods, Spirifer arenosus, Rensselaeria ovoides, Hipparionyx proximus and Meristella lata with Tentaculites elongatus, which are the species generally present in these arenaceous lenses, could not have had their habitat on such a deposit and in a sea whose depth favored such deposition. We shall not be wrong in regarding these accumulations of remains in the true Oriskany sandstone as agglomerations, swept out of their facies and away from the more calcareous, deeper water deposits of the time. To regard them as species of the sandy facies of Oriskany time would, I believe, be altogether erroneous. They appertain truly to the calcareous facies and the normal fauna of the Oriskany formation.

FAUNA OF THE GASPÉ LIMESTONES

In connection with this Oriskany fauna that of the limestones of the Gaspé peninsula, province of Quebec, requires brief consideration. This remarkable series of 2000 feet of limestones was first exploited by Sir William Logan in 1844[1] who separated them into eight divisions[2], numbering from bottom to top. The organic contents of the entire series are principally known from the description of the species by Billings[3]. This author however makes no reference to the considerable number of forms mentioned by Logan in his characterization of his subdivisions of the group. The record of species has been somewhat augmented in recent years by the lists given by Ells in his report on the geology of the Gaspé peninsula, the new identifications of which are largely ascribed to Dr H. M. Ami. This entire series of limestones was originally regarded of Siluric age; Billings afterward demonstrated and Logan conceded the similarities between the fauna of division no. 8 and that of the Oriskany of New York, while Ells and Ami are not disposed to assign to the Siluric any other part than divisions 1 and 2. This great section of limestone deposits doubtless presents the most gradual of known transitions from beds (no. 1 and 2) carrying a fauna correlating with Helderbergian time and composition, through a great thickness of sparsely fossiliferous calcareous and magnesian beds (no. 3, 4, 5, 6) into a profuse limestone fauna with most pronounced Oriskany traits (no. 7 and 8). It is not practicable to here present faunal lists resulting from the writer's recent studies of the series though these would serve to indicate the close similarity of complexion in the lower beds, 1 and 2, and the beds at Stewart's cove, Dalhousie and in the Chapman plantation, Aroostook county, Maine. In the upper beds, no. 7 and 8, the fauna carries Rensselaeria ovoides, (a small and slender variety) Megalanteris ovalis, Hipparionyx proximus, Dalmanites, very close to D. stemmatus, Stropheodonta magniventra, Camarotoechia pliopleura, C.

[1] 1st annual report geol. sur. of Canada.

[2] Geology of Canada. 1863 ch. 16.

[3] Geol. sur. Canada. 1874, vol. 2, pt 1.

dryope, Eatonia peculiaris, Leptocoelia flabellites, etc., all of which pertain to the fauna of the calcareous Oriskany of New York. With these strong Oriskany traits the fauna carries certain species which indicate the continuance of a still earlier assemblage. Billings assigned to it some species of the Helderbergian and though the majority of these identifications require careful reconsideration there is in the organic content of limestone no. 8 a notable constituent of Helderbergian origin. It is interesting to note that certain of the lower beds of division no. 8 specially at the exposure at Ship Head, Cape Gaspé, are composed of a greenish sandy limestone, extending through a thickness of not less than 150 feet. They evince thus, as do the Oriskany beds of eastern New York a considerable siliceous content though still to be regarded as calcareous deposits. Logan's subdivision of the limestone series was given with lucidity and exactitude but seems hardly to clothe this unique succession with the dignity and importance it merits. Dr Ami has suggested that the upper beds, 7 and 8, be termed the *Grand Grève limestones*, from the little village on the peninsula where these strata are best exposed and most readily accessible. To Mr Charles Schuchert and the writer, who have recently spent some time in this region, this name seems happily chosen and we have thought that with equal propriety the lower beds, 1 and 2, exposed in the base of Mt St Alban along the shore of Cape Rosier cove on the gulf of St Lawrence, may be called the St Alban limestones, while the passage beds of Billings (no. 3, 4, 5, 6) which are displayed in the fine 700 foot vertical escarpment at Cape Bon Ami, west of Cape Gaspé, may receive the name of Cape Bon Ami limestones.

Logan and Dawson in referring to the interesting outcrop of "Silurian" or "Lower Helderberg" rocks on the coast one half mile south of Dalhousie, N. B., speak of it as "Cape Bon Ami." I have also observed the locality thus given on specimens from there exhibited in the fine museum of McGill university. Lest confusion arise from the duplication of this name, I may note that the little headland in question

at Dalhousie is locally known as the "Bon Ami rocks." It is moreover, a mass of eruptive, the extremity of one of the parallel apophyses extending eastward from the great massive of Dalhousie mountain. The fossiliferous rocks are exposed for the most part in Stewart's cove, some distance south of this point.

Chapter 4

THE DEVONIC AGE OF THE HELDERBERGIAN FAUNA AND THE BASE OF THE DEVONIC SYSTEM IN NEW YORK

The fact of the presence of numerous Helderbergian species in the fauna of the Oriskany of Becraft mountain, as an integral part of that fauna, not a casual intermixture, is sufficient demonstration that the fauna of the Helderbergian became modified in its continued existence by the departure or extinction of certain of its species only. A fair percentage kept the field up to the time of and pending the incursion of species of the early Oriskany. In this way the former became a true and proper part of this new fauna with whose indicial species it coexisted throughout the remainder of its duration. A modification so gradual as to permit such an uninterrupted existence can not sever the close relation of the one fauna in its entirety to the other. It is therefore a natural corollary from the account given of the Oriskany fauna, to consider briefly the relation of the organic assemblage constituting the typical and normal Helderbergian to the Devonic type of organic life, and that formation in its relation to the Devonic system.

We may postulate this proposition: the sections on which the term, Lower Helderberg group, was based are in Albany and Schoharie counties N. Y.; it is here that the formation attains its greatest and most differentiated sedimentation as well as its highest profusion of organisms; it is therefore to these sections and their organic contents that every argument in analysis and correlation of the fauna and its containing sediments must be eventually referred.

1 THE ARGUMENT FROM CORRELATION

Since the proposition of Beyrich in 1867 to correlate the Helderbergian faunas of New York with strata in the Hartz mountains which he believed to be of lowest Devonic age, the most careful study of the lower Devonic has resulted in a like conclusion. Probably the detailed investigations following Beyrich's suggestion, by that highly accomplished student of the Devonic, Prof. E. Kayser of Marburg, effected the widespread acceptance of this correlation of the Helderbergian with the lowest Devonic, specially among European students, with whom little question of its propriety and exactitude has found expression during the last decade. The history of the earlier stages of the discussion concerning the age of these and other beds which had been at first regarded as of upper Siluric age, was given by the writer with some fulness 10 years ago,[1] and has again been presented in a recent paper by Charles Schuchert. To these the reader is referred. It is not germane to the purpose of this paper to bring forward again the history of labors which have so far as evidence from correlation goes, firmly established the Devonic age of this fauna. To enumerate the names of those who have entered into this problem is to give the full tale of the most experienced students of these faunas, Kayser, Tschernyschew, Frech, Barrois, Novàk, Oehlert and others. It is, however, quite unnecessary to seek in extra-limital correlates the evidence of such Devonic age.

2 THE ARGUMENT FROM THE INTRINSIC CHARACTER OF THE FAUNA

With whatever emphasis extra-limital correlates bespeak the Devonic age of this fauna, the strongest demonstration of its Devonic affinities is intrinsic. In the work above cited the writer brought forward in a tentative way a summation of such evidence, and since that time has taken opportunity on several occasions to refer to the increasing and convincing evidence of the proposition. No American geologist has since then given attention to the subject of the predominant

[1] 8th ann. rep't N. Y. state geologist. 1889. p. 62–91.

faunal traits of the Helderbergian, with the exception of Charles Schuchert, of Washington, who, after expressing his conviction of their Devonic character, resulting from protracted study of the brachiopods of the fauna[1] has entered into the subject in much detail and with great force.[2] George H. Girty has discussed the characters of the sponges and coelentrates of this fauna in a valuable paper published in the *14th annual report of the New York state geologist*, 1895, but without entering widely into the consideration of the faunal bearing of the species discussed. For the rest, stratigraphers, cartographers, writers of textbooks and others who have had no occasion to consider the subject on its merits and perhaps no adequate appreciation of the merits of the question, have till lately been content still to accept the view promulgated largely by the influence of Murchison, that the fauna constitutes a terminal member of the upper Siluric section in New York.

No full analysis of the constituents of the typical Helderbergian fauna can be presented here, nor is it essential. A review of the species of the entire fauna with the incorporation of the very considerable number of undescribed forms known to occur in it would be necessary to set the matter forth with its full force. It will suffice here to restate briefly the leading features of the association which must be relied on to determine its age. Let this statement, however, preface the present discussion. *The Helderbergian fauna is that contained by the strata, all and several, lying between the top of the Tentaculite (Manlius) limestone below, and the top of the Kingston beds above.*

The Helderbergian fauna

Siluric characters

Positive elements

Trilobites. There are no features presented by the trilobites which indicate Siluric age.

Cephalopods. In the Helderbergian, representatives of the cephalopods are most rare. The species of the genera Orthoceras, and

[1] *See* Bull. U.S. geol. sur. 1897. no. 87.

[2] Bull. geol. soc. America 1900. 11: 241–332.

Cyrtoceras are very imperfectly known. The little known species of Cyrtoceras are not diagnostic.

Pteropods. The species of Conularia and Tentaculites present no diagnostic characters.

Gastropods. Holopea, Diaphorostoma, Strophostylus are diffused throughout Siluric and Devonic horizons. Of all these genera Holopea alone is near its Siluric culmination.

Lamellibranchs. Cypricardinia is freely represented in the Niagaran, but its culmination is of Devonic age. Actinopteria occurs occasionally in the Niagaran, but its paucity there is in marked contrast to its abundance in the Helderbergian. There are no indubitably predevonic types in this element of the fauna.

Brachiopods. The only species of this extensive group known to be common to the Helderbergian and Niagaran faunas are the cosmopolitan brachiopods, Leptaena rhomboidalis and Atrypa reticularis. The prevalence of species of Dalmanella is suggestive of Siluric affinities. The genus is typically expressed in the species D. elegantula and D. arcuaria of the Niagaran, but attains its culmination in the Helderbergian. (D. planoconvexa, D. perelegans, D. concinna, D. quadrans). In successive faunas this means no more than the progressive development of a generic group. In time subsequent to the Helderbergian the genus is continued to the close of the Devonic.

Bilobites varica is foreshadowed in the B. biloba and B. acutiloba of the Niagaran. The genus is not of subsequent date.

Orthostrophia (O. strophomenoides and O. Halli) represents a short-lived genus, doubtfully anticipated by the Orthis fasciata of the Niagaran.

Scenidium is a genus which appeared in the Trenton, attained its maximum in the Niagaran, declined and disappeared in American faunas with the Sc. insigne of the Helderbergian. In Europe the genus continued into the middle Devonic (Sc. areola Kays.).

Of the genus Spirifer the species S. macropleura Con. is a final expression of a group (Radiati pauciplicati H.&C.) which culminated in the Niagaran.

Anastrophia, the upper Siluric representative of the earlier Parastrophia, is represented in the Helderbergian, but it was also present in the calcareous Oriskany.

Sieberella attains its highest development in the Siluric and its species (S. galeata and S. pseudogaleata) are of frequent occurrence in the Helderbergian. The type, however, does not end here, but is continued upward into the Mesodevonic, even the species S. galeata being commonly identified from these horizons by European writers.

Bryozoans. But few Siluric affinities are expressed in this group. Rhinidictya presents its latest species. Diamesopora and Callopora range from lower Siluric upward into the Onondaga limestone.

Crinoids. None of the crinoids are of distinctively Siluric character.

Cystids. The presence of Anomalocystites (though this genus occurs in the Oriskany), Lepadocrinus, Sphaerocystites, is suggestive of waning Siluric traits. The cystids are not absent from succeeding faunas, but are of rare occurrence.

Corals. Duncanella rudis of the Helderbergian is anticipated by D. borealis of the Niagaran and succeeded by D. truncata of the Onondaga.

Enterolasma (E. strictum) is the last representative of a genus which makes its other appearance in the Niagaran.

Graptolites. Girty has described Monograptus beecheri from the Helderbergian. Before this interesting discovery we had no knowledge of the continuation of the rhabdophorous graptolites beyond the Niagaran fauna except in the case of Dictyonema, which is not uncommon in the Mesodevonic. There are several structural features, indicated by Mr Girty's description and figure, which indicate that M. beecheri will not prove a representative of the Monograptus type of the Siluric. Frech has expressed the view that such forms are probably Retiolites.

Negative elements

The absence of the Devonic types, Cryphaeus and Goniatites, is noteworthy.

Devonic characters

Positive elements

Trilobites. This element is, for the purposes of a diagnosis, of the first importance. The trilobitic genera present are Homalonotus, Bronteus, Dalmanites, Phacops, Acidaspis, Lichas, Proetus, Cordania and Cyphaspis.

The single species of Homalonotus (H. vanuxemi) possesses the strongly annulated pygidium characterizing the earlier representatives of the genus (e. g. H. delphinocephalus of the Niagaran, H. major of the Oriskany) and in this respect is in strong contrast to the latest members of the genus, with obsolete pygidial ribs. On the other hand, the species presents the smooth, unlobed glabella of the prevalent H. dekayi of the Hamilton, and therein indicates a progress from the Siluric type of Trimerus to the Devonic Dipleurae.

Bronteus barrandii is a species with comparatively small pygidium, having a simple, unbifurcated median rib; representing a group prevailing in the lower Devonic faunas of Europe.

Dalmanites. The typical expression and phyletic normal of this genus (Odontochile) is represented by a series of Siluric and Devonic forms in which the glabellar lobation is without coalescence and the pygidium more or less caudate. This type is foreshadowed in the lower Siluric (D. achates Billings), and the Niagaran species, D. limulurus, D. vigilans and D. verrucosus, express the structure without modification. The outburst of dermal extravagances which characterizes many Devonic trilobitic genera is foreshadowed in this group in the snouted D. bicornis of the Niagaran, a tendency perpetuated and carried to extreme in D. tridens and D. nasutus of the Helderbergian. A different style of ornament is evinced in D. pleurotopyx of the Helderbergian (a species which continued its existence into the Onondaga limestone). Here the frontal margin becomes crenulated, and this tendency is more highly elaborated in the D. dolphi and D. dentatus of the calcareous Oriskany. This style of ornament associated with simple glabellar lobation disappeared with the disappearance of D. pleuroptyx in

the Onondaga. In Cryphaeus of the Mesodevonic the lobation is retained, but the marginal ornament has disappeared from the cephalon and appears on the pygidium. The cephalic ornamentation in the species, D. stemmatus, Oriskany, D. regalis, and D. anchiops Schoharie grit, and D. selenurus, etc. of the Onondaga limestone is associated with lobal coalescence and may be looked on as an instance of morphic equivalence.

Phacops is represented by P. logani (P. hudsonicus). The species mentioned are typical Phacopes, forms in which the glabellar lobes are almost or quite coalesced, the glabella ventricose and the pygidium short. Such typical forms are not known in any earlier American fauna. In general this genus divides itself into two groups, in one of which the glabellar furrows are represented by faint, linear impressions, and the pleura of the pygidium are duplicate; in the other the furrows are obsolete and the pygidial pleura simple. The latter is believed to be limited to Mesodevonic faunas (P. rana, Hamilton, P. latifrons, Eifelian), while the former is widely disseminated as a characteristic Paleodevonic group. To this belong the Helderbergian species.

Of Acidaspis we have two species; A. tuberculata is related to the Onondaga A. callicera. The remarkable A. hamata (genus Dicranurus) with long, recurved cervical horns, finds its only known analogue and almost specific identity in the A. monstrosa, Barrande, of the etage G (Paleodevonic).

Lichas is represented by L. pustulosus, the most abundant species, which seems to indicate a type of subgeneric structure not elsewhere presented. L. consanguineus belongs to the subgenus Arges and has species both in the Siluric and Devonic.

The single species of Proetus (P. protuberans) in the Helderbergian of New York is of rare occurrence. In type of structure it conforms throughout to the series P. conradi, Oriskany, P. angustifrons, Schoharie grit, P. clarus, Onondaga limestone and P. rowi of the Hamilton group.

Cordania makes its earliest appearance in the Helderbergian,

and is represented in the Oriskany, Schoharie grit, Onondaga and Hamilton faunas.

Cyphaspis coelebs (the only species) is closely allied to C. minusculus of the Oriskany and Onondaga.

Gastropods. This group is characterized by an immense development of the genus Platyceras, which has been but sparingly represented in the Siluric faunas, but attains its numeric climax in species here and in the Onondaga and Hamilton. The prevalence of these forms is one of the most striking characters of "Hercynian" faunas, and Barrois has suggested that they may with propriety be designated by the name *Capulian.* The type Orthonychia attains its culmination in the Helderbergian and Ulsterian; the nodose species, which become abundant in the Oriskany and Onondaga, are represented; while the lamellose species and the ventricose, platystomoid forms are predominant. The spinose group, prevailing in the Onondaga and Hamilton, has not been observed here.

The genera Strophostylus and Platystoma have both more abundant representation in earlier and later faunas, and are not diagnostic.

Lamellibranchs. The prolific development of pterinaeoids stands in sharp contrast to their comparative paucity in the Niagaran, while it is in harmony with their abundance in the Devonic. (Avicula textilis, A. communis, A. obliquata, A. manticula, A. securiformis, A. pauciradiata, etc.). Aviculopecten has a well developed representation (A. tenuilamellata, A. spinulifera, A. schoharie, A. umbonata, A. bellula).

Mytilarcas of large size and gibbous form, belonging to the Devonic subgenus Plethomytilus, are abundant in individuals (M. ovata, M. cordiformis).

Conocardium has but a meager representation in the single, rare species, C. inceptum. This genus is but sparingly known in Siluric faunas.

A large species of Modiomorpha (M. oblonga); undescribed species of the genera Grammysia, Goniophora, Paracylas are also known.

Brachiopods. Rhipidomella, which culminates in the Mesodevonic, is largely represented. But a few doubtful representatives are known in the Siluric.

Schizophoria, eminently characteristic of the higher Devonic, is clearly defined in the Helderbergian. The only earlier species of the genus is generically inchoate. Orthothetes is in the line of progress from its elementary forms in the Niagara to its abundant development in the middle and upper Devonic. It is represented by two species, O. deformis and O. woolworthana.

Leptostrophia, beginning its development here becomes a large and characteristic Devonic group.

Brachyprion, well advanced in structure toward the type of Stropheodonta, is represented by two species. Progress along the same line continues in the Oriskany and thereafter the type seems to lose itself in the latter genus.

Strophonella, starting in the Siluric, attains its culmination in the Helderbergian (S. headleyana H., S. leavenworthana H., etc., and gradually declines to the close of the Devonic.

Leptaenisca is not known elsewhere in American faunas.

Chonostrophia is known only in the Helderbergian, Oriskany and Onondaga.

Spirifer. The lamellose septati, represented by Sp. perlamellosus, become culminant in later Devonic faunas.

The same is true of the Fimbriati unicispinei, (S. saffordi, S. cyclopterus, S. octocostatus) which are preceded by an inceptive representation in the Niagara and followed by several species in the Devonic.

Of the Aperturati the only species is S. concinnus, the earliest representative of the S. orestes subtype. This entire group becomes culminant in the Devonic and lower Carbonic.

The genus Merista is known in America only in the Helderbergian and Oriskany faunas.

Meristella has a remarkable development in this fauna and its existence is continued through the Mesodevonic. It is not known in the Siluric.

A similar outburst of species is afforded by the genus Trematospira (T. multistriata, T. costata, T. perforata, T. simplex). The genus is here culminant, the small T. camura of the Niagara being the only preexisting species.

Parazyga is known only here and in the Mesodevonic.

Nucleospira is here near its culmination with a considerable subsequent development into the Mesodevonic.

Stenoschisma is not elsewhere known.

Uncinulus attains its culmination here (U. mutabilis, U. abrupta, U. vellicata, U. nucleolata).

Eatonia is known only in the Helderbergian and Oriskany faunas.

Sieberella (S. galeatus and S. pseudogaleatus) occurs widespread in the upper Siluric, and a common middle and upper Devonic shell is referred by European paleontologists to S. galeatus.

Rensselaeria (R. mutabilis, R. aequiradiata, R. elliptica, etc.) makes its first appearance here and disappears with the close of the Oriskany.

Trigeria is known in America only in the Helderbergian (T. portlandica Square lake Me.) and Oriskany (T. gaudryi Oehlert, Cumberland Md.) faunas.

Cryptonella begins its existence in the Helderbergian (C. eximia) and is continued into the lower Carbonic.

Bryozoans. The sum of the characters of this element points strongly toward the Devonic. Rhombipora, Diamesopora, Coelocaulis, Callotrypa, Fistulipora, Lichenalia, have a few representatives in the Siluric, but are here much progressed toward or to their culmination. Paleschara, Stictopora, Craniopora, abound in later faunas. The fenestelloids (Fenestella, Unitrypa, Hemitrypa, Polypora) are relatively few in the Siluric, greatly abound in the Helderbergian, but attain their culmination in the Mesodevonic. The genus Thamniscus makes its first appearance here.

Crinoids. Edriocrinus occurs only here and in the Oriskany.

Mariacrinus, a subgeneric expression of Melocrinus, attains its culmination in this fauna. Coronocrinus, Cordylocrinus, Camarocrinus, Brachiocrinus and Aspidocrinus are not known elsewhere.

Corals. The development of explanate Favosites is notable and in direct accord with their progress toward culmination in the Onondaga limestone.

Striatopora and Aulopora attain their culmination in the Devonic.

Pleurodictyum here makes its first appearance.

Zaphrentis has a meager representation (Z. roemeri); its culmination is in the Onondaga limestone. The same is true of Cladopora and Vermipora.

Of the stromatoporoids, Girty has described five species of Syringostroma, a genus not known in earlier faunas but occurring in the middle Devonic.

Sponges. Hindia fibrosa, though occurring in the Siluric, is here at its most profuse development, and its existence is carried upward into the Onondaga limestone (Onondaga county).

Negative elements

Trilobites. The Siluric genera Bumastus, Calymmene, Staurocephalus, Encrinurus, Sphaerexochus, Platynotus, Crotalocephalus, are absent.

Cephalopods. The group is but very sparsely represented. There are no representatives of the genera Ascoceras, Actinoceras, Oncoceras, Hormoceras, Cyrtoceras (of Siluric type), Pentacoceras, Hexacoceras, or any characteristic Siluric types.

Lamellibranchs. Ambonychia, Anomalodonta, Tellinomya, Clidophorus and Modiolopsis are wanting.

Brachiopods. The entire family of the Trimerellidae (Trimerella, Dinobolus, Monomerella, Rhinobolus, Lingulops, Lingulasma), which was so profusely represented in the late Siluric, is absent.

Orthis (s. s.) disappears in the Niagaran; probably also, Plect-

orthis and Hebertella. The upper Siluric genera Mimulus and Streptis are absent.

Strophomena has not been perpetuated beyond the Siluric.

Plectambonites disappears in the Niagaran.

Of the genus Spirifer, we have no representative of the S. nobilis type (Radiati duplicati).

The genera Whitfieldella, Hyattella, Dayia, Hindella, Meristina, Glassia, Zygospira are absent.

Rhynchotreta and Parastrophia disappear with the Niagaran.

Conchidium, Pentamerus, Barrandella and Stricklandinia are not present.

No terebratuloid genus is known in the upper Siluric.

Eichwaldia disappears with the Niagaran.

These genera of Crinoids disappear with the Niagaran fauna: Eucalyptocrinus, Glyptaster, Thysanocrinus, Marsupiocrinus, Lyriocrinus, Lampterocrinus, Lecanocrinus, Pisocrinus, Allocrinus, Coccocrinus, Dendrocrinus, Ampheristocrinus. None of the following Niagaran genera of Cystoids continue beyond that fauna: Caryocrinus, Callocystites, Lysocystites, Gomphocystites, Allocystites, Halocystites, Hemicosmites, Apiocystites, Heterocystites.

This statement of the affinities of the various generic elements of the Helderbergian fauna is more graphically represented as below. The direction of the dashes indicates either (forward) Devonic or (backward) Siluric affinity.

Trilobites

Dalmanites (Synphoria)—
Phacops—
—Homalonotus
Bronteus—
Acidaspis—

Lichas—
Proetus—
Cordania—
Cyphaspis—

Cephalopods

—Orthoceras—

—Cyrtoceras—

Pteropods

—Tentaculites—
—Conularia—

Gastropods

Platyceras—
Orthonychia—
—Strophostylus—
—Diaphorostoma—
—Holopea

Lamellibranchs

Actinopteria—
Aviculopecten—
Mytilarca—
Conocardium—
Modiomorpha—
Cypricardinia—
Grammysia—
Goniophora—
Paracyclas—

Brachiopods

—Dalmanella—
Rhipidomella—
Schizophoria—
—Bilobites
—Orthostrophia
—Scenidium
Orthothetes—
Brachyprion—
Leptostrophia—
Strophonella—
Christiania
Leptaenisca
Chonostrophia—
—Spirifer—
Merista—
Meristella—
Trematospira—
Parazyga—
—Nucleospira—
Stenoschisma
Lissopleura
Uncinulus
Eatonia—
—Sieberella—
—Anastrophia—
Rensselaeria—
Trigeria
Cryptonella—

Bryozoa

—Rhinidictya
—Diamesapora
—Callopora—
Rhombipora—
Coelocaulis—
Callotrypa—
Fistulipora—
—Lichenalia—
Thamniscus—
Paleschara—
Stictopora—
Fenestella—
Unitrypa—
Hemitrypa—
Polypora—

Crinoids

Mariacrinus—
Coronocrinus
Cordylocrinus
Brachiocrinus
Aspidocrinus

Cystoids

—Anomalocystites—
—Lepadocrinus
—Sphaerocystites

Corals

Duncanella—
—Enterolasma
Zaphrentis—
Favosites—
Aulopora—
Striatopora—
Pleurodictyum—
Cladopora—
Vermipora—

Graptolites

—Dictyonema—
—Monograptus ?

Stromatoporoids

Syringostroma—

Sponges

—Hindia—

3 THE ARGUMENT FROM STRATIGRAPHY

The fact that the faunas of the Manlius limestone and the Rondout waterlimes are not, in this discussion, considered a part of the fauna of the Helderbergian has already been stated. The distinctive differences in these faunas are briefly noted in the following chapter.

In eastern central New York there is no interruption in the stratigraphic succession from the Manlius limestone upward. The heavy layers of this formation are generally capped by a Stromatopora limestone. In the westward extension of the Helderbergian, the Coeymans and New Scotland limestones gradually lose their individuality. In the records of salt, gas and artesian wells throughout the district west of Cayuga lake the strata referred to the Lower Helderberg, often of considerable thickness, present nothing of the true Helderbergian. These vague and indeterminate assignments cover for the most part the blue limestone, generally quite pure and often

hydraulic, found between the base of the Onondaga or of the Oriskany sandstone when present, and the Rondout waterlimes lying above the gypsum beds. These beds are the stratigraphic equivalent of the Tentaculite limestone, for they contain species which characterize this horizon in eastern New York, though Tentaculites itself is rarely seen in the western exposures.

At the quarries of the Buffalo cement co. at Buffalo, is a section of unusual interest to which brief reference has been made. Above the Rondout waterlimes the strata which bear the fauna of the Manlius limestone are continuous to the base of the Onondaga limestone.

The quarrymen divide this portion of the section into "cement rock" below and "bullhead" above, and, though the lower passes gradually into the upper, it is in the former (Rondout) that the species of eurypterid crustaceans prevail, while in the latter fossils are not common, though the horizon is pretty well defined by an undescribed species of Cyathophyllum with representatives of Whitfieldella sulcata and Spirifer cf. vanuxemi (S. eriensis Grabau). This "bullhead" waterlime occupies the position of and is coextensive with the Manlius limestone and is the Manlius horizon. The upper surface of this deposit is extremely uneven, and seldom conforms with the approximately parallel sedimentation lines of the rock itself. In parts of the quarry, where this surface has been exposed on a large scale by the stripping of the Onondaga limestone above, the contour is extremely irregular, and the depressions in some cases take on the aspect of crooked channels running into one another, the effect being just that which would result from the probable cause, erosion before the deposition of the Onondaga limestone commenced.

The horizon of the Oriskany sandstone is indicated only by a thin seam of fine, bituminous matter, containing no sand except in a few of the depressions mentioned, where small characteristic nodules of black sand are found.

In certain parts of this section the upper hydraulic or "bullhead" strata show very positive evidence of disturbance and folding and at certain places the crest of these folds is seen to be partially removed,

while the Onondaga limestone beds lie horizontally on them. All these evidences are indicative of an interval of unrepresented time between the deposition of the Manlius limestone and the commencement of Onondaga sedimentation. These evidences are distinctly corroborated by the following accessory phenomena.

The same quarry shows several nearly vertical fissures which have been filled with white, compact quartz sand. The most clearly developed of the three such fissures here observed is shown in the accompanying plate and diagram. This is an irregular fissure transecting the strata nearly vertically, with horizontal apophyses running out along the sedi-

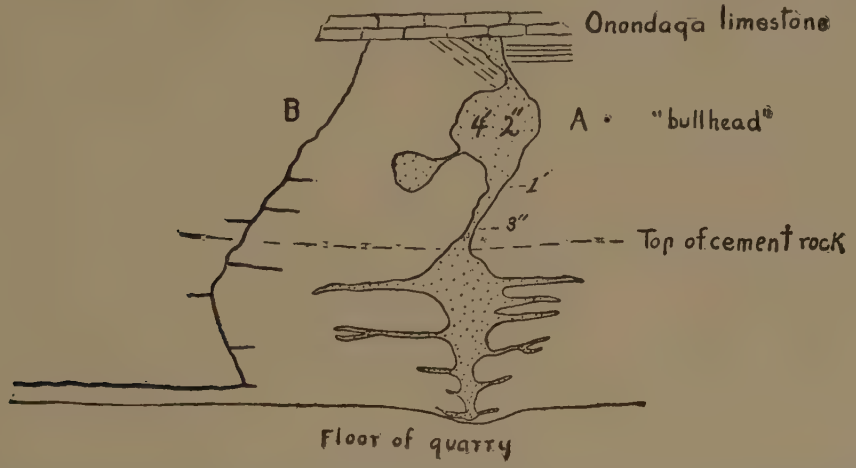

Diagram showing the largest of the sand dikes (A) in the quarries of the Buffalo cement co., at Buffalo N. Y. The floor of the quarry is the lowest layer used for burning cement and while the dike seems to enter this stratum it does not penetrate it. The figure shows the irregular character of the fissure walls, and the lateral apophyses in the lower part which are essentially parallel to the bedding. At the top is a slight displacement of the "bull-head" or Manlius waterlime on one side of the dike. B shows a second dike, the filling of a very narrow fissure. Others are evident elsewhere in this quarry. The Onondaga limestone lies horizontally over them all and is not penetrated by them.

mentation planes and across them at various angles. It is filled with firmly cemented quartz sand having the aspect and quality of typical Oriskany sandstone. The top of this fissure is in the Oriskany horizon and the overlying Onondaga limestones are undisturbed. It extends downward across the entire series of waterlimes to and perhaps below the base of the quarry. This disturbance and fracture of the strata, which has possibly been extended by solution and accompanied by a slight displacement on one side, must have taken place after the consolidation of the Manlius limestone and before the deposition of the undisturbed Onon-

daga limestone. This event belonged to the interval of the Helderbergian and Oriskany deposition elsewhere in New York, and the filling of the fissure is, doubtless, veritable Oriskany sediment.

We have already observed that at various localities throughout western and central New York the thin, cherty deposit of the Oriskany contains fragments of the hydraulic limestone from beneath. This condition was particularly noticeable in the remarkable section afforded by the salt shaft put down at Livonia, Livingston co. Such organic remains as occurred in this deposit were found entirely in the cement and were not well preserved, but showed indications of having been worn and broken by the waves. Evidence of this kind sufficiently demonstrates an interval between the Manlius and Onondaga limestones unrecorded in these sections, and shows the continuity of the rocks carrying the fauna of the former with the sedimentation immediately preceding and their discontinuity with the sedimentation of the true Helderbergian period.[1]

FAUNA OF THE MANLIUS LIMESTONE

The species of the so-called "Tentaculite limestone", so far as noticed, have been principally described in volume 3 of the *Paleontology of New York*, and the citations given in that work are of occurrences located mainly in the eastern and eastern-central parts of the state. Even where the limestone is in immediate contact with and conformable to the overlying deposits of the Helderbergian, there are few evidences of the continuation of any well established species above the "Tentaculite limestone" itself. In eastern-central New York a repetition of the Manlius fauna may appear after a brief preliminary invasion of the later and displacing fauna but in these oscillations be-

[1]After writing this account of the physical disturbances in the strata at Buffalo, based on observations made in 1899, I learned that the phenomena had also been studied by Dr A. W. Grabau, who has published the result of his detailed investigations in a recent bulletin of the Geological society of America (2:347–76, 1900. Siluro-Devonic contact in Erie county, N.Y.) Grabau concludes that these fissures were formed by violent rupture of the waterlimes before the incoming of the sandy sediment subsequently washed in from above.

tween the retreating and invading faunas there is seldom evidence of a commingling of species. In the Helderberg section the commonly occurring fossils are Tentaculites gyracanthus Eaton, Spirifer vanuxemi H., Brachyprion varistriatum H., Megambonia? aviculoides H., Modiolopsis? dubia H., Beyrichia notata H. and B. trisulcata H.

The number of forms which were assigned by Prof. Hall to this horizon is 22, but some of them, particularly species of Holopea, Euomphalus, Oncoceras and Cyrtoceras, are of quite uncertain character. It has been remarked in a foregoing paragraph that the Tentaculites which are so abundant in eastern New York appear only with extreme rarity in the westward extension of the formation. At Union Springs, Cayuga co., the Manlius limestone has a more prolific fauna than has been observed elsewhere west of Herkimer county. Attention was specially directed to this occurrence by Prof. S. G. Williams in a paper read before the American association for the advancement of science in 1885 and an article entitled "Note on the Lower Helderberg rocks of Cayuga lake", which appeared in the report of the New York state geologist for 1896, p. 10–12. Prof. Williams here gave a list of 26 species which he had identified from localities in this vicinity.

The most favorable spot for the examination of this fauna is in the rocks exposed on Frontenac island, just off the village of Union Springs. These are blue gray hard limestones from 8 to 10 feet in thickness, lying over the Rondout waterlimes, which are about 25 feet thick and carry Eurypterus remipes. Above the blue limestones waterlimes again appear, and for a while the fauna of the Frontenac island beds retreats, but reappears in the hydraulic strata lying below the Oriskany sandstone at Yawger's woods, 2 miles north of the village. My identifications of the species do not in all respects agree with those made by Prof. Williams, and our differences concern almost entirely such species as he recorded as found in the eastern subdivisions of the Helderbergian.

The limestone layers are characterized by two distinct beds of a Stromatopora or Stromatocerium, and it is between these that

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the more productive fossiliferous beds occur. In part these beds are made up of masses of the lamellibranch Ilionia sinuata, a species described by Hall as Anatina? sinuata, from Herkimer county. It is by far the most abundant of all the species here present.

Ilionia is a generic type of strong Siluric cast, represented by the well-known and highly characteristic Lucina prisca of Wahlenberg, from the upper beds on the island of Oesel. Other species are a form of Hormoceras, a strong Siluric type, and a Cyrtoceras or Gyroceras making more than one revolution, a small form of Oncoceras, perhaps that identified by Williams as O. ovoides Hall, but which appears to me different in several respects. This genus, Oncoceras again indicates the Siluric affinity of the fauna. There are species of Orthoceras both smooth and annulated, which have not yet been satisfactorily identified. Among the gastropods are some species of Holopea which are hardly identifiable. Also an Euomphalus, which may be compared with the E. sinuatus Hall of this horizon. Spirifer vanuxemi and Brachyprion varistriatum, which occur throughout the extent of the limestone east and west, are here quite abundant. Also the Atrypa sulcata Vanuxem, which proves to belong to the genus Whitfieldella, and a large unidentified form of the genus Chonetes. I look on the discovery in this fauna of Halysites catenulatus as of much significance. Though not abundant, the species is thoroughly characteristic. Another coral is present, doubtless that referred to by Prof. Williams as Zaphrentis sp., which I find to have the characters of the new genus Charactophyllum, and to be most closely allied to the C. (Cyathophyllum) radiculum Rominger, of the Niagaran fauna. A few other species have been observed but not in condition for satisfactory identification.

It is perfectly clear without farther argument that the types expressed in the foregoing list are very positively indicative of Siluric age, and, furthermore, that they have nothing in common with the true Helderbergian fauna. No single species of the list and none of the generic forms here cited, such as Hormoceras, Oncoceras, Ilionia (or Platymermis), Whitfieldella, Halysites and Charactophyllum,

pass over into later faunas. No additional evidence is required to establish the individuality of the fauna of the Manlius limestone and its affiliation with the Siluric. As the names of several species appear on Prof. Williams's list which belong to the Helderbergian, I feel it necessary to add that of the following I have found no trace: Lingula rectilatera, Orthostrophia strophomenoides, Nucleospira ventricosa, Holopea danai.[1]

[1] Dr Grabau's study of the organic remains of the Manlius limestone of Erie county (*op. cit.*) which was to some extent based on collections from this horizon in the N. Y. state museum have resulted in the identification of a considerable number of species. As this work has issued since the foregoing matter was in type his results are briefly presented. Following are the species:

Nematophytum crassum Penhallow

Cyathophyllum hydraulicum Simpson (MSS.). This species is everywhere abundant throughout the western extent of the Manlius waterlimes.

Orthothetes hydraulica Whitfield. Originally described from Bellville and Greenfield O.

Spirifer eriensis Grabau. This species has commonly passed under the name of S. vanuxemi which, as noted by Whitfield and others, is hardly distinguishable from S. crispus as it occurs in the Coralline limestone at Schoharie.

Whitfieldella sulcata Vanuxem

Whitfieldella cf. rotundata Whitfield

Whitfieldella cf. laevis Whitfield

Loxonema ? sp.

Pleurotomaria ? sp.

Trochoceras gebhardi Hall

Leperditia scalaris Jones

The most striking feature of this little fauna is its similarity to that of the Coralline limestone of eastern New York, the representative of the Niagaran formation in that region. This is seen in the similarity of Spirifer eriensis to the S. crispus as identified by Hall from that formation, of Whitfieldella cf. rotundata with W. nucleolata of the same formation. The presence of Trochoceras gebhardi in both and the close relationship of Leperditia scalaris Jones with L. jonesi Hall of the Coralline limestone. Dr Grabau's conclusion from the study of this fauna as well as of the tectonic relations of the strata in Erie county emphasizes the strongly Siluric character of the Manlius limestone.

EXPLANATION OF PLATES

PLATE 1

Phacops logani Hall

Page 21

FIG.

1, 2 Superior and profile views of a cephalon, showing the minute genal spinule and faint glabellar furrows

3, 4 Portions of other cephala in which the eye is retained

5 A pygidium, showing the duplication of the lateral ribs. x3

Dalmanites (Synphoria) stemmatus sp. nov.

(*See* Plate 2)

Page 15

6 An incomplete internal cast of the cephalon, showing the frontal ornament and the fused glabellar lobes

7, 8 More complete specimens of the cephalon, showing general form and structure

9 A front view of the latter, showing the elevation of the shield and eyes

10 A part of the head taken from a mold of the exterior and showing the marginal ornament in detail

11, 12 Hypostomas of two individuals

13 A small and unsymmetrical pygidium

14 The internal cast of a large pygidium, its apparent width greatly increased by the loss of the posterior border

15, 16 Two pygidia of normal outline and structure

ORISKANY FAUNA.

Memoir 3. N.Y. State Museum. Plate 1.

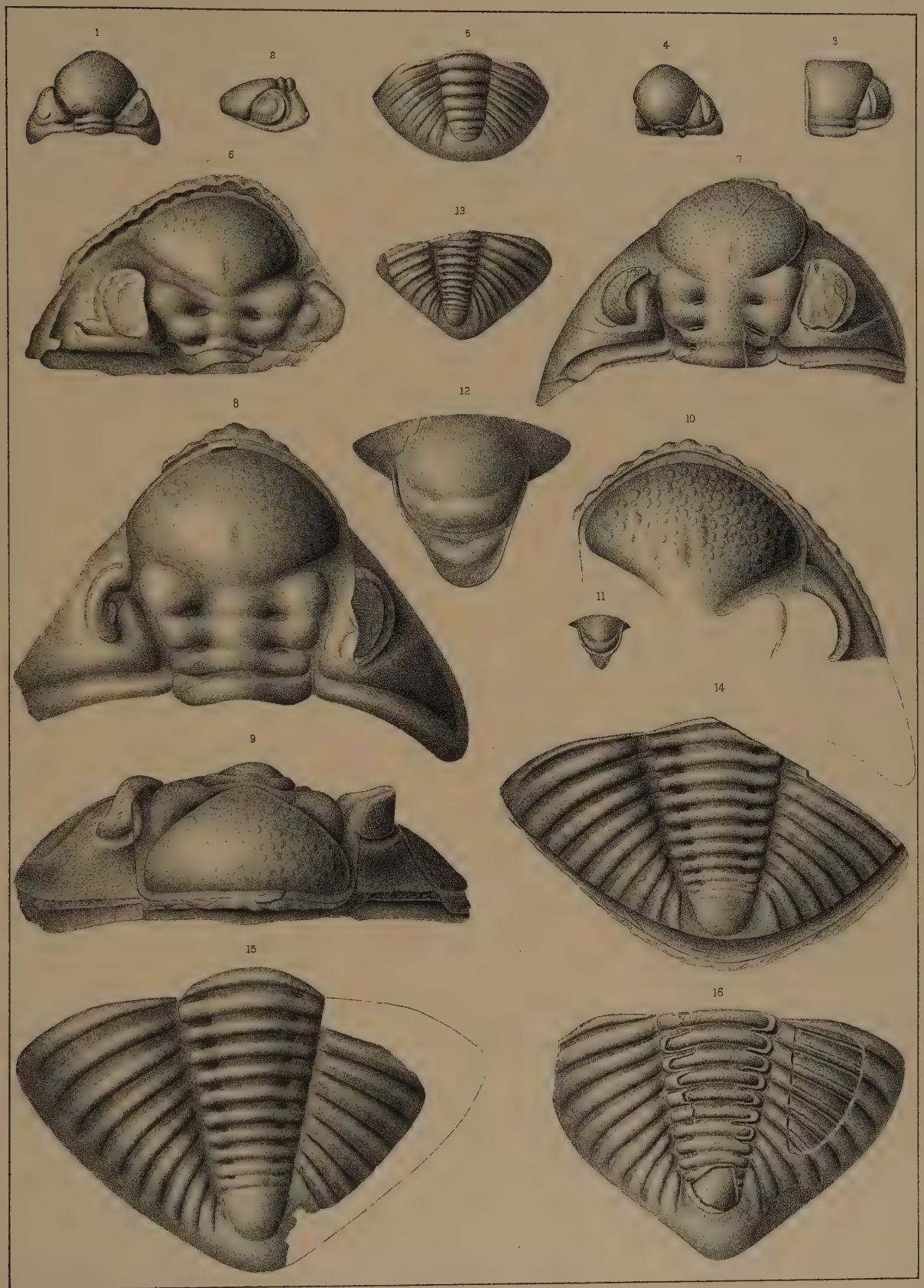

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PLATE 2

Dalmanites (Synphoria) stemmatus sp. nov.

(*See* Plate 1)

FIG. Page 15

1, 2 The frontal doublure of two cephala showing the marginal ornament

Dalmanites (Synphoria) stemmatus.

var. **convergens** var. nov.

Page 19

3 An incomplete and somewhat distorted cranidium
4 A pygidium of usual size and proportions
5 Another pygidium more obtuse at the extremity

Dalmanites bisignatus sp. nov.

Page 19

6–8 Pygidia of this species, showing the form and character of ornament

Phacops correlator sp. nov.

Page 20

9 A cephalon restored in outline, showing the dalmanitiform character of the glabella and the rounded cheeks. x3

Dalmanites phacoptyx Hall & Clarke

Page 19

10 A portion the very characteristic pygidium of this species

Proetus conradi Hall

Page 25

11–13 Portions of the cephalon, more or less flattened
14 An uncompressed glabella with traces of the lateral furrows
15 The pygidium
16 Internal cast of an essentially entire individual

Cordania hudsonica sp. nov.

FIG. Page 24

17 An internal cast of the pygidium. x2

18 A pygidium with portion of the exterior showing the ornament. x3

Cordania becraftensis sp. nov.

Page 22

19, 20 Two pygidia, showing surface markings. x3

21, 22 Two cranidia, natural size

23 A portion of the cranidium, enlarged to show the character of the ornament. x2

Cyphaspis minuscula Hall (sp.)

Page 24

24, 25 Two cranidia. x3

Acidaspis tuberculata Conrad

Page 25

26 The cranidium. x3

Autodetus beecheri Clarke

Page 26

27 The internal cast of the spiral tube lying in the natural mold of the fossil. x3

28 A specimen showing the cast spiral tube and a part of the exterior wall

29 The exterior of the species with a Fistulipora growing on the surface

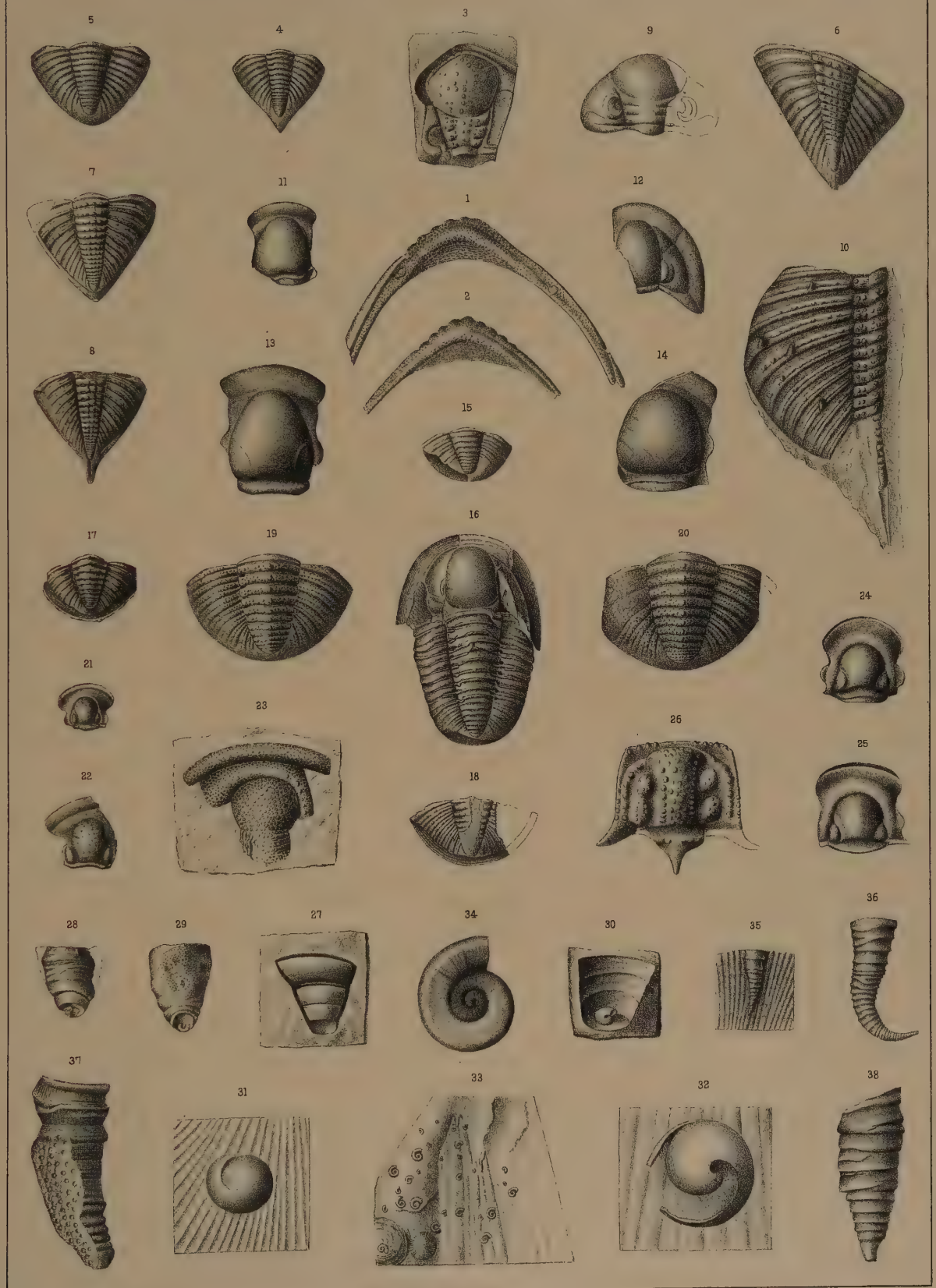
30 The interior wall of the shell with the casts of the spiral tubes removed except that of the initial volution which lies on the surface of attachment. x3

31 The initial form of the shell, attached to the surface of a brachiopod. This is a highly convex bulb, which is not overlapped by the early part of the first volution. x5

32 A somewhat more progressed condition with more of the spiral tube remaining. x5

ORISKANY FAUNA.

Memoir 3. N.Y. State Museum. Plate 2.



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Spirorbis assimilis sp. nov.

FIG. Page 26

33 A group of these tubes on the internal surface of a valve of Meristella

34 The upper surface of a specimen. x10

Cornulites cingulatus Hall

Page 27

35 A small tube attached to the edge of a valve of Orthothetes. x3

36 A larger example. x3

37 A large tube, showing surface of attachment to a Fistulipora. x3

38 Internal cast of another specimen. x3

PLATE 3

Tentaculites (?) acus sp. nov.

Page 28

FIG.

1 A specimen which shows the smooth exterior and the annulated or insheathed cast of the interior. x3

2 The exterior, showing low annular depressions

3 The internal cast. x3

4–7 Specimens of natural size, showing the generally smooth or slightly corrugated exterior

Tentaculites elongatus Hall

Page 27

8 The initial end of a specimen, showing its smooth exterior and the character of the internal cast. x5

9 External and internal casts. x2

10 Enlargement of the apical portion of the tube, showing the smooth area and gradual development of annulations and concentric lines. x10

11 The character of the surface at maturity. x5

12 A portion of the exterior, natural size

Diaphorostoma desmatum sp. nov.

Page 29

13–15 Three views of an average specimen

16, 17 Views of other specimens

18 The upper surface of a larger shell, showing the lineation

19 An enlargement of the surface characters. x6

Cyrtolites expansus Hall

Page 28

20 Upper view of a slightly distorted specimen, for the most part an internal cast

ORISKANY FAUNA.

Memoir 3. N.Y. State Museum. Plate 3.

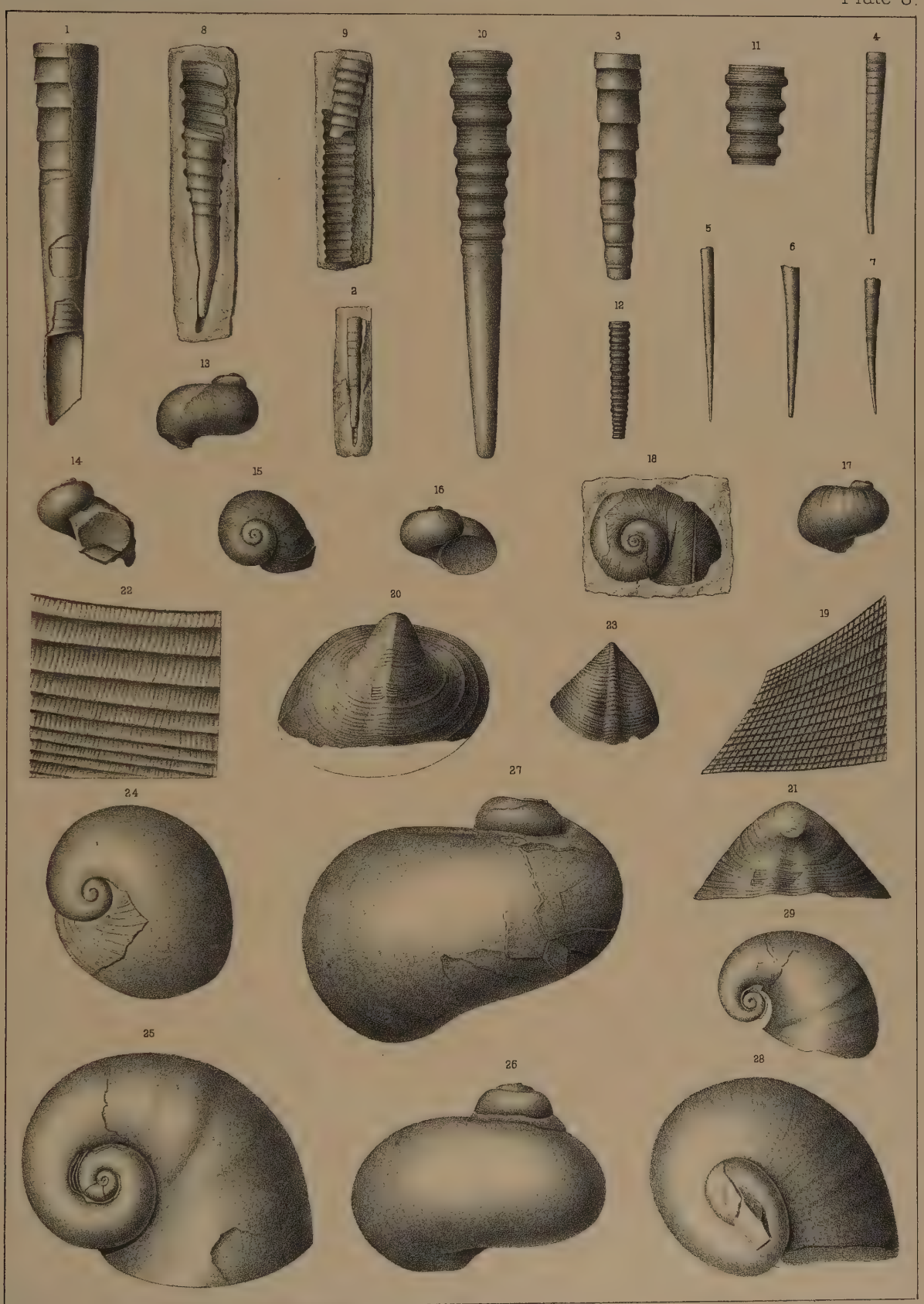

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FIG.

21 Posterior view of the same specimen showing the sub-apical groove

22 An enlargement of the external ornament. x6

23 A smaller example with more strongly developed median carina

Strophostylus expansus Hall

Page 30

24 An upper view of a characteristic specimen

Diaphorostoma ventricosum Hall

Page 30

25–28 Views of various specimens showing the general aspect of the shell in this fauna

Platyceras cf. **gebhardi** sp. nov.

Page 30

29 Lateral view of an internal cast of this species

PLATE 4

Actinopteria communis Hall

Page 34

Fig.

1, 2 Right and left valves of the same shell, showing the character of the surface

Pterinopecten signatus sp. nov.

Page 33

3 A left valve showing the form and external ornament

Pterinopecten proteus sp. nov.

Page 32

4–7 Right and left valves of this species, which show the wide variation in external characters

8 An enlargement of the surface characters of one of these shells. x2

Pterinopecten pumilus sp. nov.

Page 33

9 The right valve of this species. x3

Actinopteria insignis sp. nov.

Page 35

10, 11 Two left valves showing the form and external characters of the species

12, 13 Enlargement of the surface characters from different parts of the same shell. x5

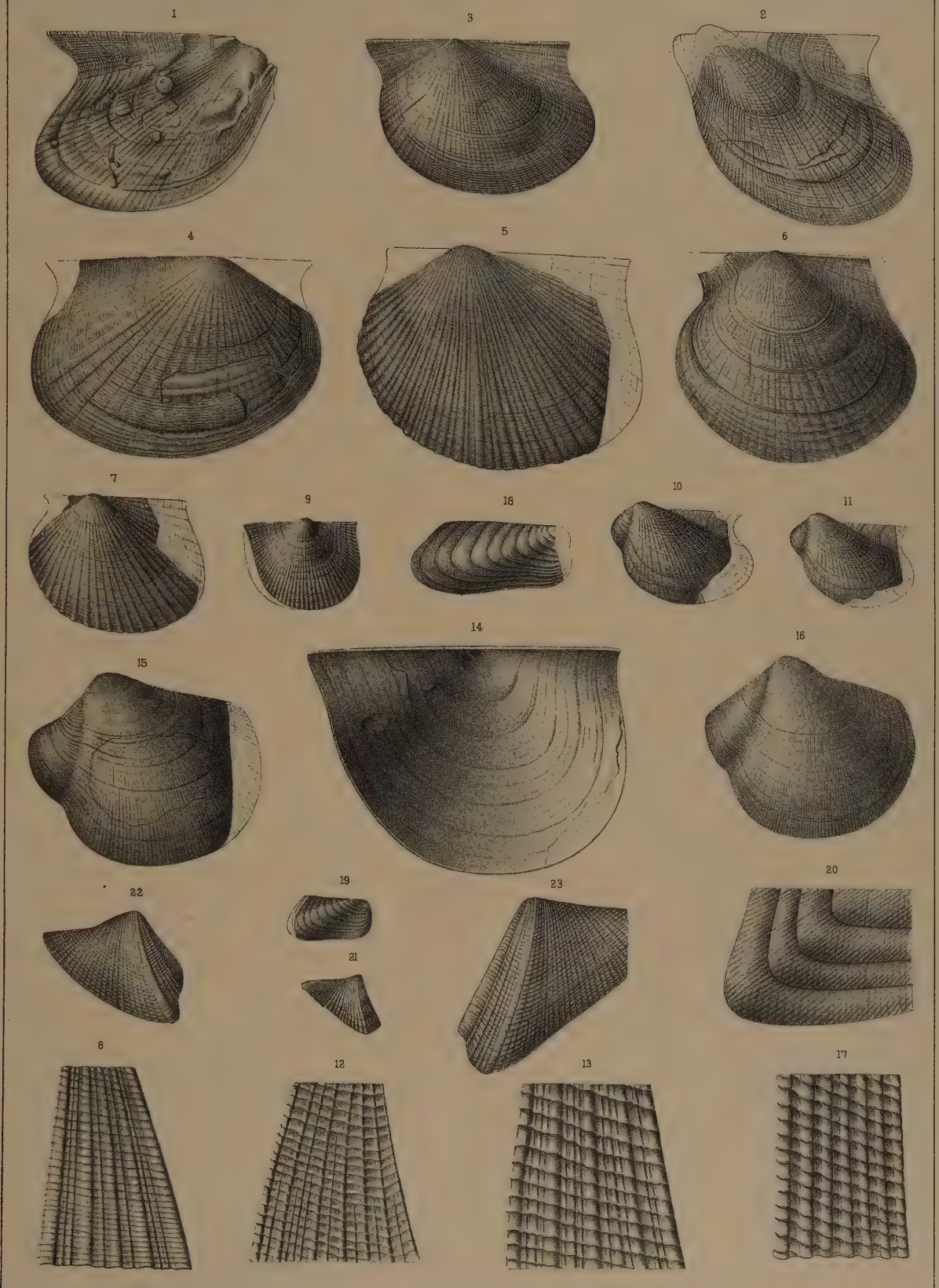
Pterinopecten subequilateralis Hall (*emend.*).

Page 31

14 An external cast of the surface of a right valve, showing the absence of radial ornament

ORISKANY FAUNA.

Memoir 3. N.Y. State Museum. Plate 4.



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Megambonia crenistriata sp. nov.

Page 35

FIG.

15, 16 Two left valves, showing the outline, contour and ornament

17 Enlargement of the surface. x5

Cypricardinia indenta Hall

Page 36

18 A nearly complete right valve. x2

19 Another valve, natural size

20 Enlargement of a portion of the surface. x5

Conocardium inceptum Hall (?)

Page 37

21 A specimen, natural size

22 Another shell enlarged, showing the character of the surface. x3

23 The opposite valve from a larger specimen. x3

PLATE 5

Cryptonella (?) fausta sp. nov.

Page 38

FIG.

1–3 Dorsal, profile and ventral views of a typical example

4–6 Similar views of another shell showing the depressed convexity of the brachial valve

7, 8 Ventral and profile views of another example

Oriskania sinuata sp. nov.

Page 38

9, 10 Dorsal and profile views of a specimen which show the convexity of the brachial valve

11 Another example showing the same characters

12 An example showing the muscular and vascular scars on a cast of the brachial valve

Megalanteris ovalis Hall

Page 40

13, 14 Dorsal and profile views of a characteristic example

15 An enlargement of the surface showing the imperforate exterior layer and the perforate inner layer of the shell

16 An internal cast of the pedicle valve showing the muscular and vascular scars

Rensselaeria ovoides Eaton

Page 39

17, 18 Profile and dorsal views

19 Internal cast of a pedicle-valve showing the muscular impressions

Camarotoechia sp. cf. **dryope** Billings

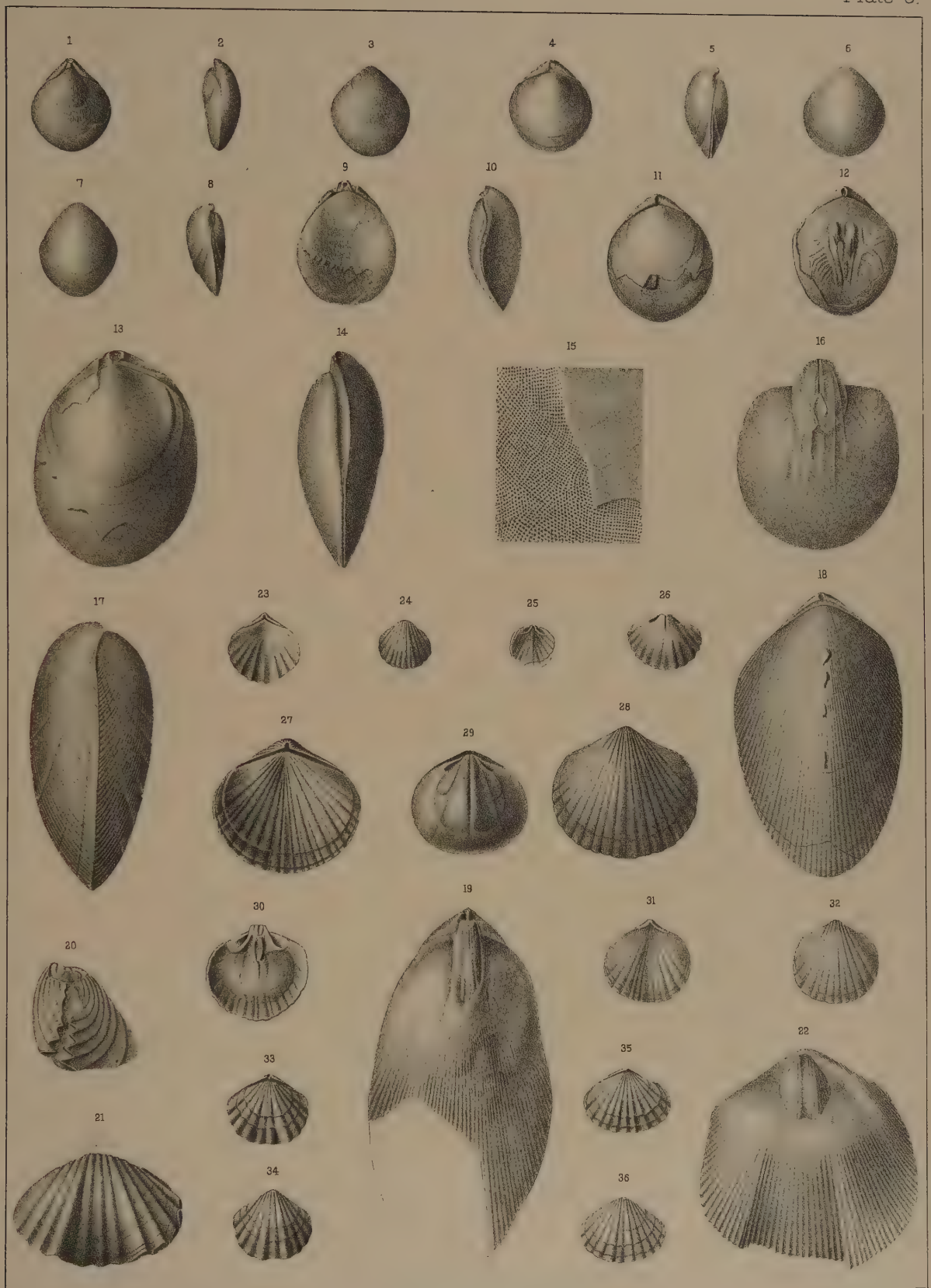
20, 21 Profile and ventral views of an imperfect specimen

Camarotoechia oblata Hall

22 An internal cast of a pedicle-valve

ORISKANY FAUNA.

Memoir 3. N.Y. State Museum. Plate 5.



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Coelospira concava Hall

Page 42

FIG.

23 Dorsal view. x3

24 Ventral view. x2

25 The interior of the brachial valve. x2

26 The interior of the pedicle-valve showing the muscular impressions. x3

Coelospira dichotoma Hall

Page 42

27 Dorsal view of the exterior. x3

28 Ventral view of the exterior of the same specimen. x3

29 Internal cast of the pedicle-valve showing the muscular scars. x3

30 View of the interior of the brachial valve. x2

31, 32 Dorsal and ventral views of the exterior. x2

Leptocoelia flabellites Conrad

Page 42

33, 34 Dorsal and ventral views of an average specimen

35, 36 Dorsal and ventral views of the specimen in which the fold and sinus are not so pronounced

PLATE 6

Trematospira multistriata Hall

Page 43

FIG.

1, 2 Dorsal views showing the character of the exterior

3 Dorsal view of a smaller shell with strongly duplicate plications

4 Enlargement of the surface of the shell. x5

Meristella lentiformis sp. nov.

Page 44

5, 6 Dorsal and profile views of a characteristic specimen

7 Dorsal view of an internal cast showing the existence of a strong median septum in the brachial valve

8–10 Dorsal, profile and ventral views showing the characteristic contour of the species

11 Internal cast of the pedicle-valve showing the strong muscular scar

Meristella ? vascularia sp. nov.

Page 45

12–14 Internal casts of the pedicle-valve showing strong dental lamellae, pedicle cavity and muscular impressions and the radiating sinuses over the vascular region

Cyrtina varia sp. nov.

Page 49

15 Enlargement of the surface showing its pustulose character

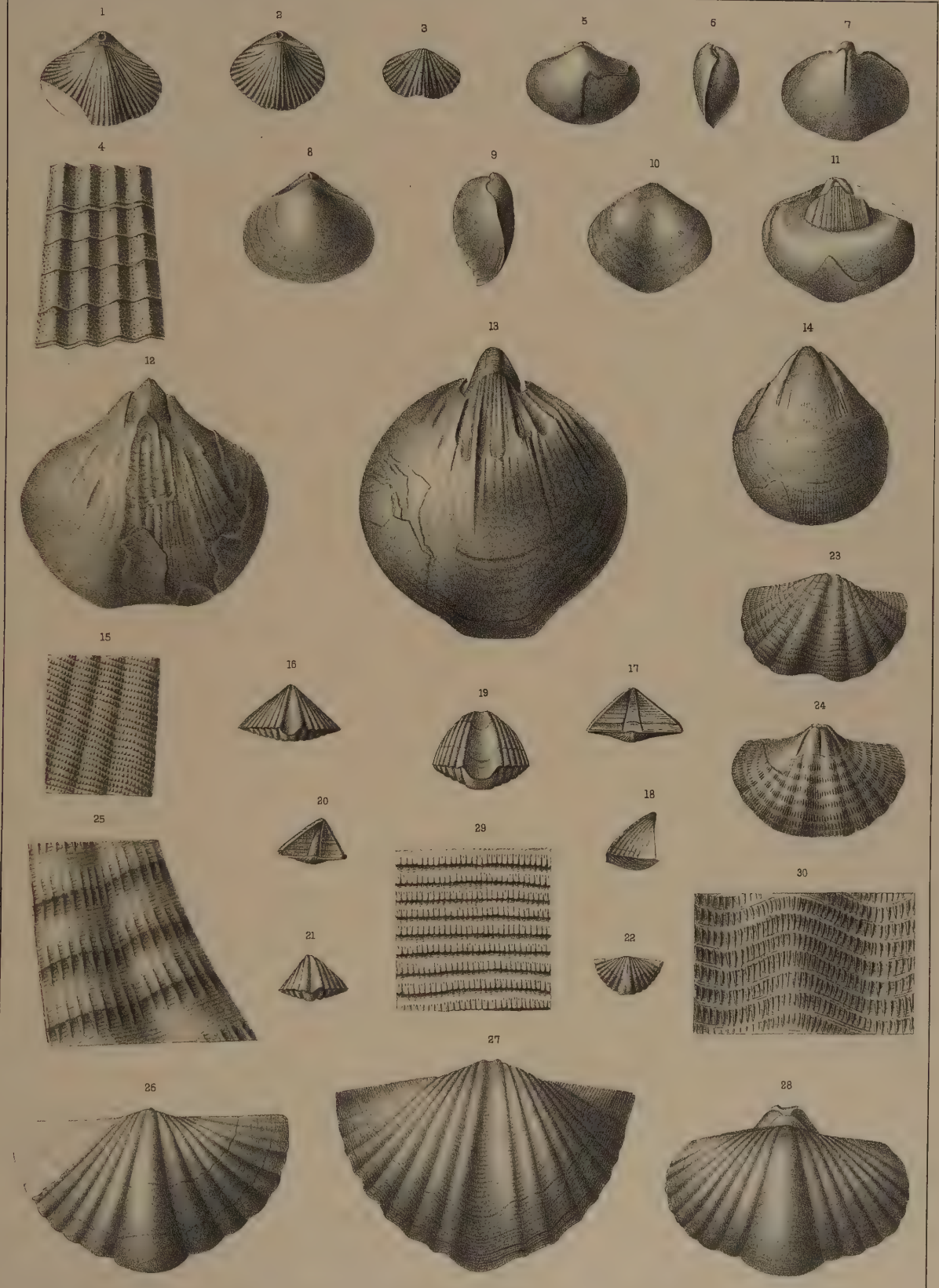
16–18 Anterior, posterior and profile views of an average specimen

19 Anterior view of a larger specimen with convex pedicle-valve

20–22 Three views of a smaller specimen

ORISKANY FAUNA.

Memoir 3. N.Y. State Museum. Plate 6.



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Spirifer saffordi Hall

Page 48

FIG.

23, 24 Exteriors of pedicle-valves showing the fimbriate surface. In fig. 23 the rows of these fimbriae are more numerous and closely crowded than in the other. x2

25 A portion of the surface enlarged showing the character of the spine bases on the concentric growth lines. x10

Spirifer murchisoni Castelnau

Page 46

26 An incomplete brachial valve

27 A ventral valve of large size showing the fimbriate surface

28 A specimen showing the brachial valve with the internal cast of the ventral muscular impressions

29 An enlargement of the surface showing the concentric rows of short hollow spinules. x10

30 A similar enlargement in which only the bases of the spinules are shown. x10

PLATE 7

Chonetes hudsonica sp. nov.

Page 49

FIG.

1 The exterior of the pedicle-valve
2 The interior of the brachial valve
3 An external cast of the pedicle-valve
4, 5 Pedicle and brachial valves. x2
6 The surface striations enlarged. x4

Chonostrophia complanata Hall

Page 50

7 Ventral view of a small specimen
8 Internal cast of a pedicle-valve of average size
9 The interior of the pedicle-valve
10 Internal cast of a pedicle-valve with somewhat more elongate outline
11 Exterior of a pedicle-valve of a large individual
12 Enlargement of the surface. x5
13 Interior of a large pedicle-valve

Anoplia nucleata Hall

Page 51

14 Dorsal view of a specimen retaining both valves. x3

Orthothetes becraftensis sp. nov.

Page 51

15 The interior of a pedicle-valve
16, 17 Exteriors of pedicle-valves
18 The cardinal process of the brachial valve. x3
19 The exterior of a small brachial valve. x2
20 Exterior of a small pedicle-valve
21 The interior of a young pedicle-valve attached by the substance of its shell to the surface of a *Meristella*. x2

ORISKANY FAUNA.

Memoir 3. N.Y. State Museum. Plate 7.

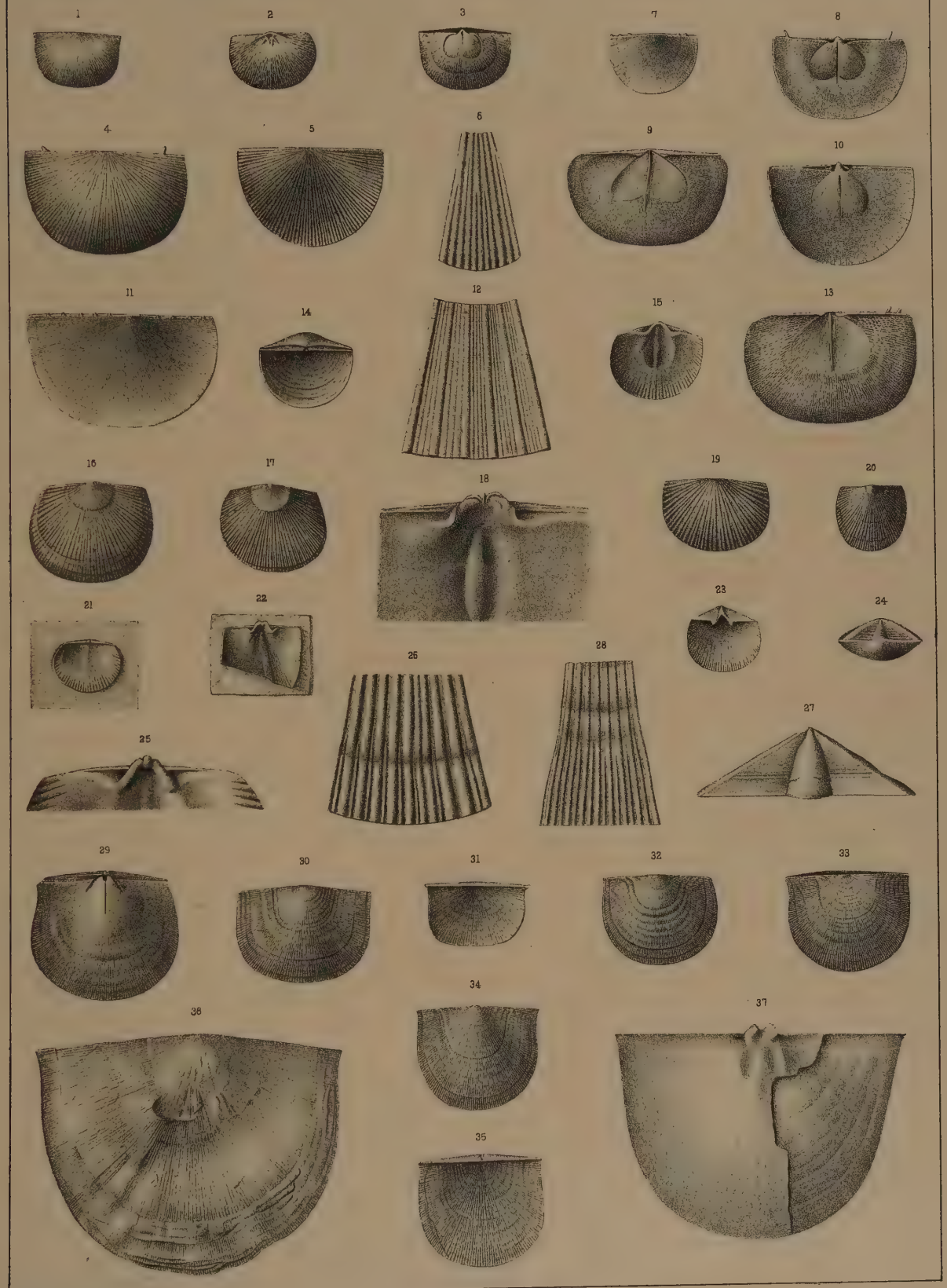

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FIG.

22 The interior of an incomplete brachial valve showing the cardinal process

23 Interior of the pedicle-valve showing the cardinal area and deltidium

24 Posterior view of a specimen bearing conjoined valves and showing the elevated cardinal area

25 Cardinal process of the brachial valve. x3

26 A portion of the external surface enlarged

27 The cardinal area of the pedicle-valve showing the deltidium. x3

Leptostrophia oriskania sp. nov.

Page 53

28 An enlargement of the external surface. x5

29 Sculpture cast of the pedicle-valve

30, 32, 34 The external surface of pedicle-valves showing their variations in outline and the undulated surface

31, 35 The exterior of brachial valves

Leptostrophia cf. **magnifica** Hall

Page 53

36 The exterior of the ventral valve of a small shell which may represent this species

Stropheodonta lincklaeni Hall

Page 52

37 A specimen of the dorsal valve showing a portion of the interior with cardinal process and also a part of the external surface

PLATE 8

Brachyprion schuchertanum sp. nov.

Page 56

FIG.

1 The apical portion of the brachial valve showing the coarse angular striae similar to those of Strophe o-donta arata Hall. x3
2 The exterior of the brachial valve
3 External cast of brachial valve
4 The exterior of an incomplete pedicle-valve
5 The exterior of a brachial valve
6 An imperfect interior of the brachial valve
7 An enlargement of the external surface showing the character of the ornament. x5

Brachyprion majus sp. nov.

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8 The character of the external surface. x5
9 The exterior of the pedicle-valve, the umbo of which is made somewhat too conspicuous
10 The interior of the pedicle-valve
11 An internal cast of the pedicle-valve showing the muscular impressions
12 The exterior of the brachial valve
13 The cardinal area of the pedicle-valve showing the short rows of denticles on either side of the deltidium

Rhipidomella oblata Hall

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14, 15 Views of the exterior

Crania pulchella Hall and Clarke

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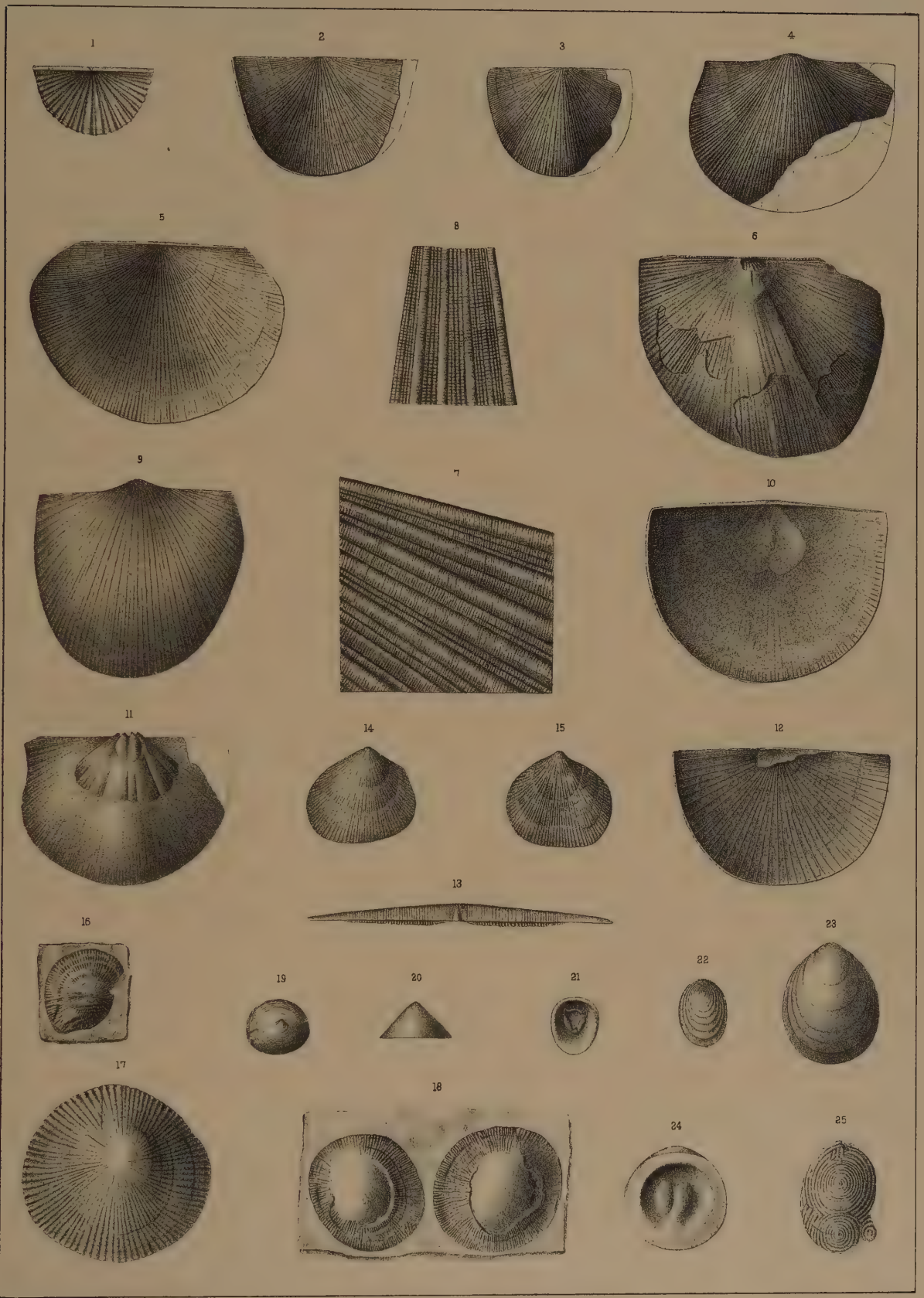
16 An incomplete specimen showing marks of attachment
17 A more complete example. x3
18 Two specimens exfoliated at the apex

ORISKANY FAUNA.

Memoir 3. N.Y. State Museum. Plate 8.



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Crania cf. bella Billings

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FIG.

19 The upper valve

20 Profile view of a very young example showing the regular conical form. x10

Pholidops sp.

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21 The interior of one of the valves

22 The exterior. x5

Pholidops terminalis Hall

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23 The exterior of the larger valve. x3

24 The interior showing the muscular scars. x3

25 A valve showing replacement of the shell by a series of chalcedonies formed concentrically about centers of silicification

PLATE 9

Cladopora styphelia sp. nov.

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FIG.

1, 2 The exterior of branches of this species

Cladopora smicra sp. nov.

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3–5 Branches of this coral, natural size

6 An enlargement of the exterior. x3

Vermipora streptocoelia sp. nov.

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7 Portion of the frond showing the character of the tubes as they emerge on the surface. x2

8 The same species with the external silicified layer removed showing the meandering character of the tubes in the substance of the coral beneath the surface. x2

Hederella ramea sp. nov.

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9 A characteristic colony showing the diffusely branching frond, the whole being attached to a specimen of Leptostrophia oriskania. x3

Hederella magna sp. nov. and **Hederella graciliora** sp. nov.

Page 61, 62

10 The surface of a brachiopod covered with fronds of these species, the coarser frond with the larger tubes being Hederella magna and the finer zoarium H. graciliora. x2

Hederella arachnoidea sp. nov.

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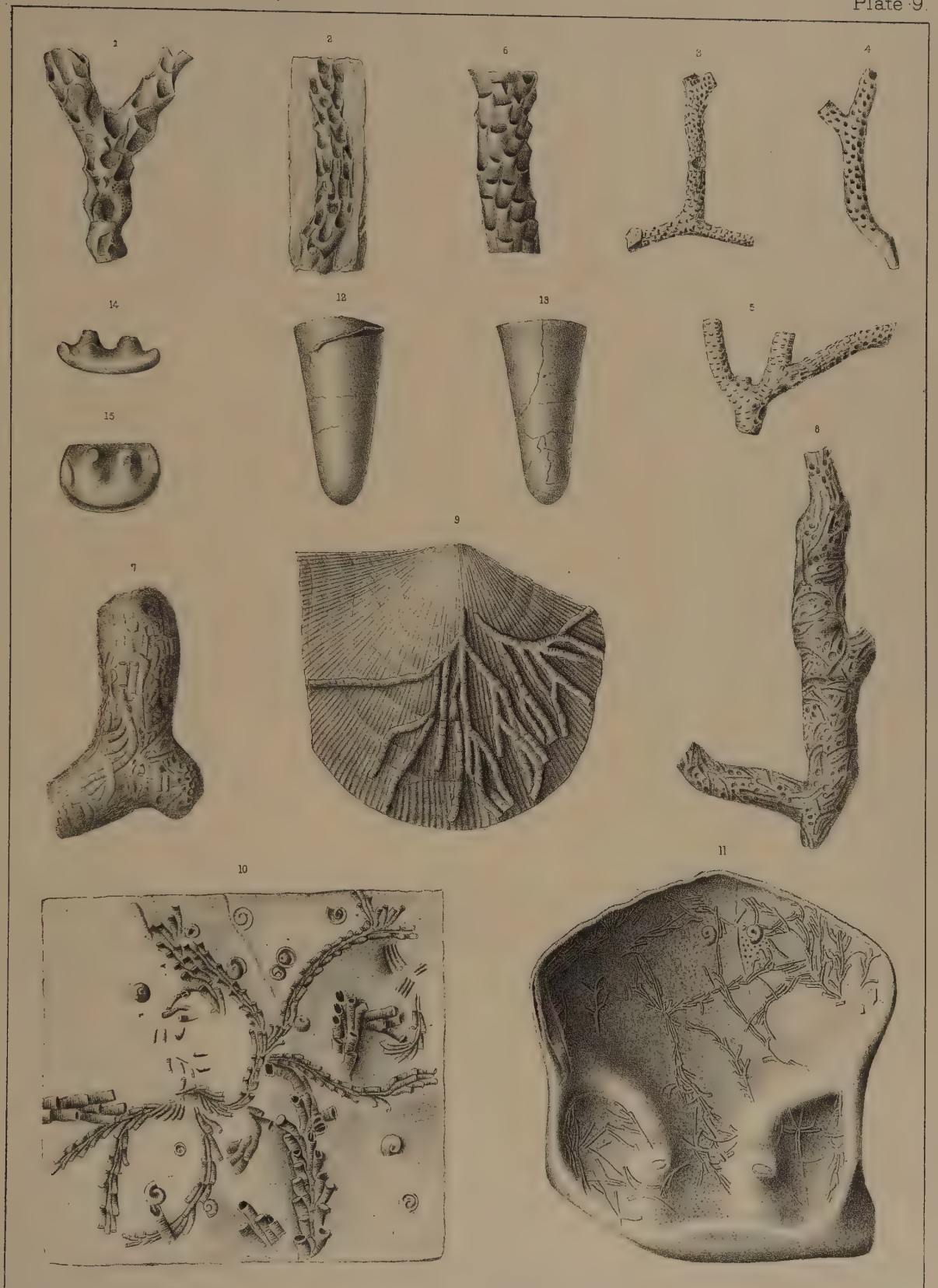
11 The internal surface of the glabella of Dalmanites stemmatus covered with the fine fronds of this species. x2

ORISKANY FAUNA.

Memoir 3. N.Y. State Museum. Plate 9.



G B Simpson del James B. Lyon. State Printer Philip Ast lith.

Edriocrinus becraftensis sp. nov.

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FIG.

12, 13 Views of the calyx of this crinoid

Beyrichia sp. ?

14 View from the anterior margin. x10

15 View showing the outline and nodes of the valve. x10

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